United States Patent [19]

Stannard

[11] **3,948,712**

[45] **Apr. 6, 1976**

[54] **METHOD AND APPARATUS FOR PRODUCING CLOSED LOOP ACCORDION PLEATED FILTERS**

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[73] Assignee: **Sprinter System of America, Ltd.,** East Windsor, Conn.

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[21] Appl. No.: **510,221**

[52] **U.S. Cl.**..... **156/218;** 93/77 R; 93/82; 156/443; 156/466

[51] **Int. Cl.**[2] **B31F 1/00**

[58] **Field of Search**.... 156/443, 218, 466, 356–357; 93/82, 77 R, 36.05, 36.1, 36.2, 39 C, 39.2, 39.3; 53/44, 229, 371; 113/7 R, 7 A, 8, 11 R

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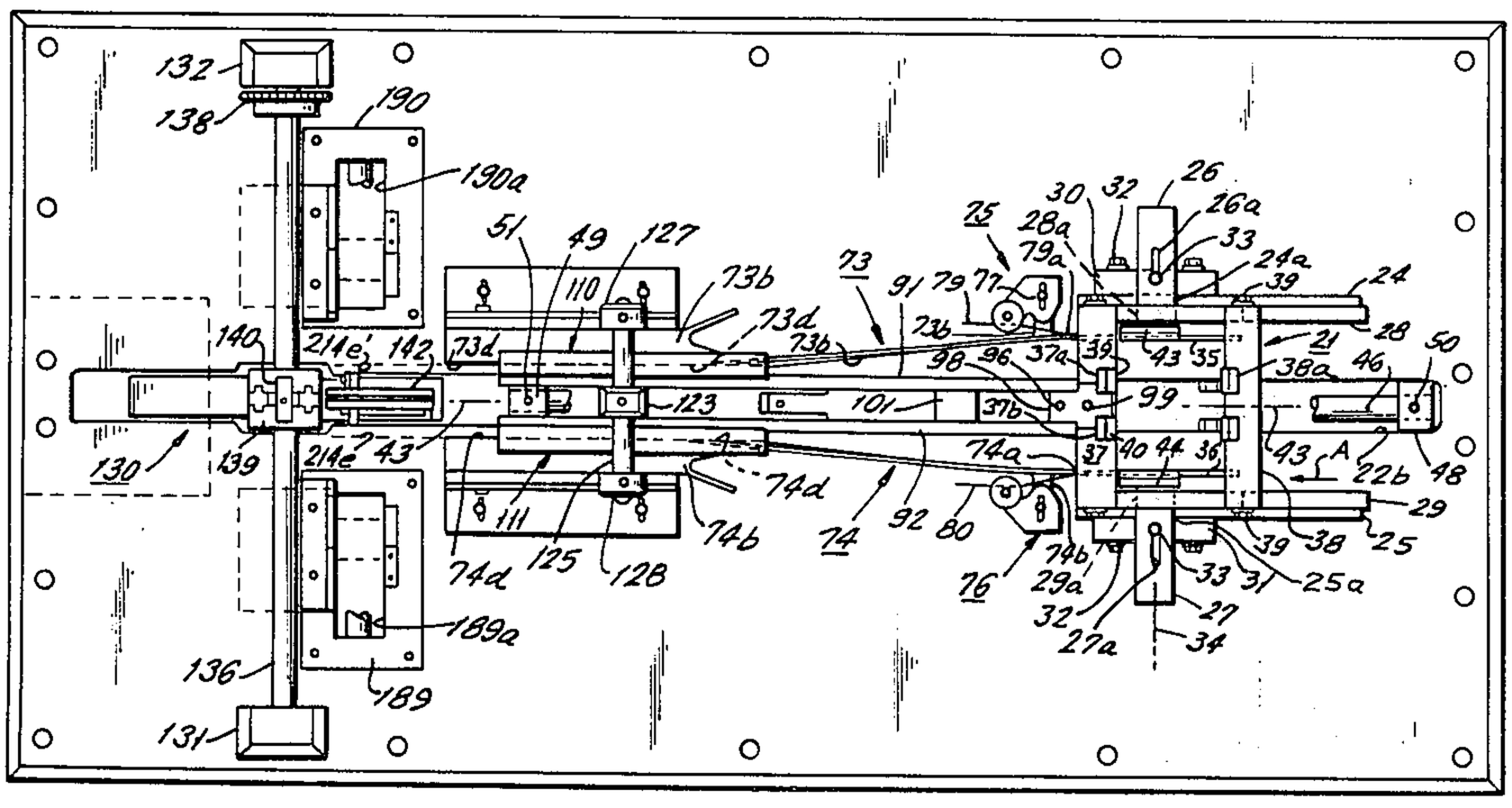
Primary Examiner—William A. Powell
Assistant Examiner—David A. Simmons
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

Method and apparatus for producing closed loop accordion pleated filters. Accordion pleated filter structures are advanced from a feeder hopper one at a time by pusher members and guided along guide means arranged in a converging fashion and which pass between the endmost pleats to bring the ends of the pleated filter toward one another. Second pusher means then move the pleated filter, which is now arranged in a substantially U-shaped configuration, along the guide members to orient the outermost pleats into a substantially common horizontal plane. Third pusher means move the outermost flaps upon a pair of blades and substantially surrounding one arm of a paddle wheel assembly. A suitable hot melt is deposited upon the surfaces of one of the outermost flaps. The blades swing downwardly and move toward one another to press the outermost flaps having a hot melt deposited thereon into firm engagement. The blades remain together for a period sufficient for the adhesive to at least partially "set" and are then lifted upwardly and away from the filter to prevent separation of the flaps joined by the hot melt. The paddle wheel supporting the completed filter element rotates towards stripper means which pushes the completed closed loop accordion pleated filter off of the paddle wheel arm and onto an output conveyor. The operation is completely automated from the time that the accordion pleated filters are placed in the infeed hopper.

23 Claims, 21 Drawing Figures



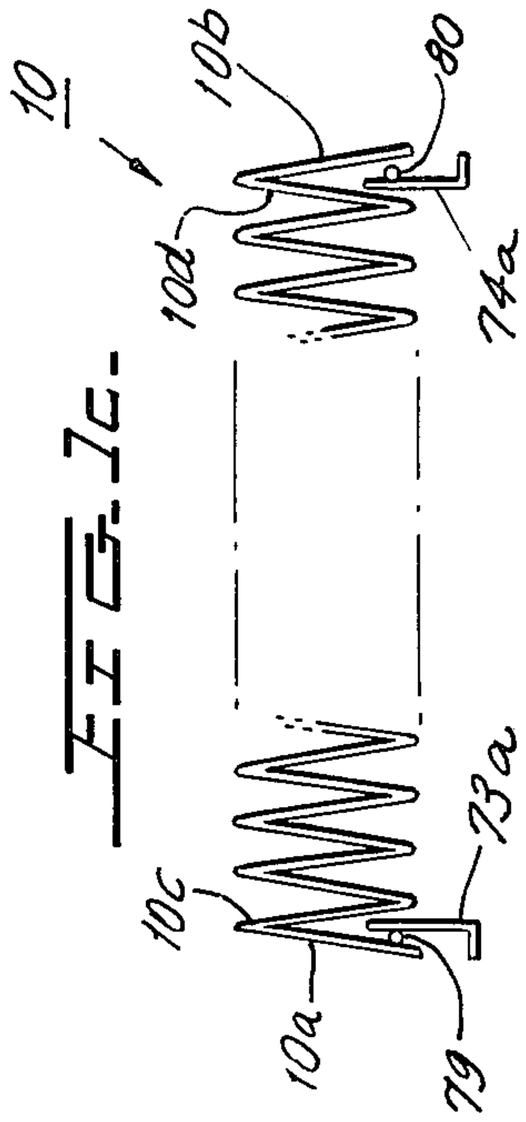


FIG. 1c.

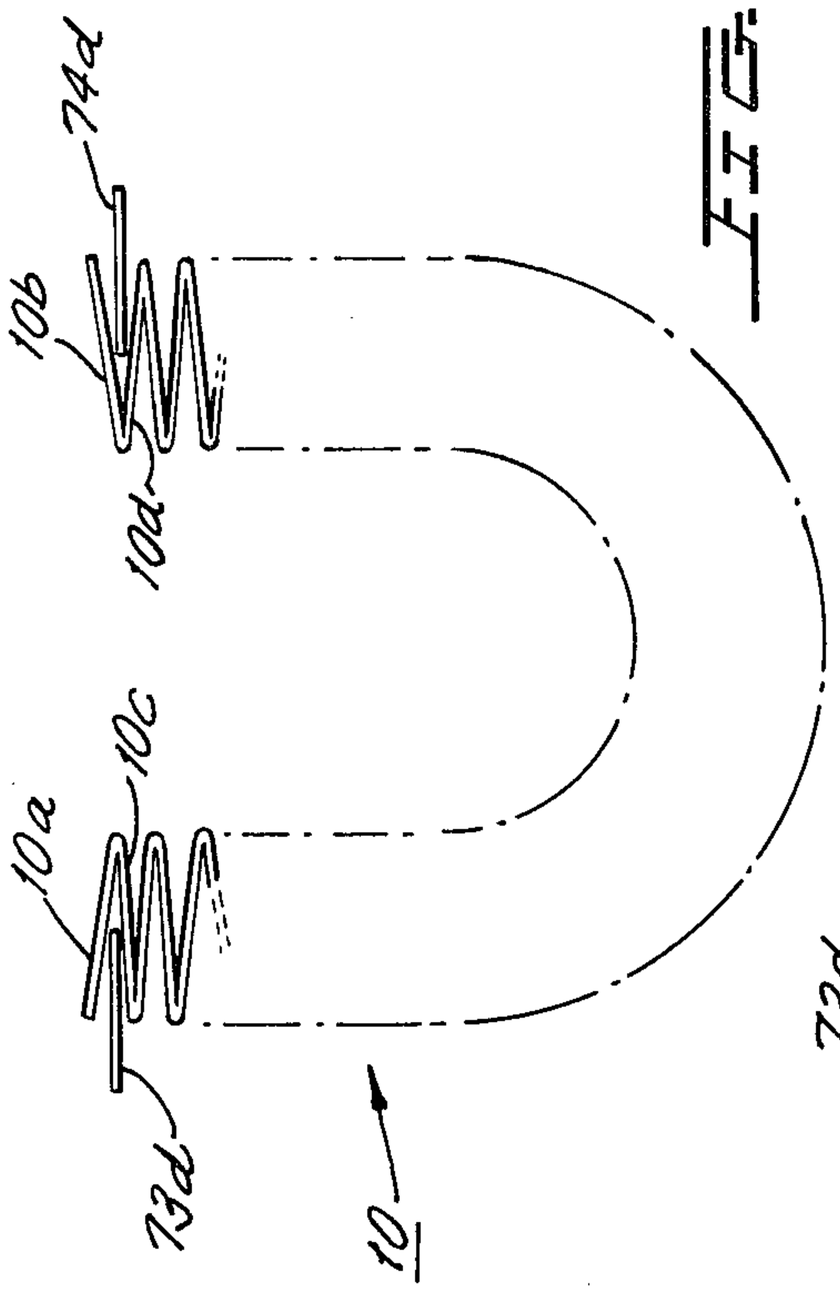


FIG. 1d.

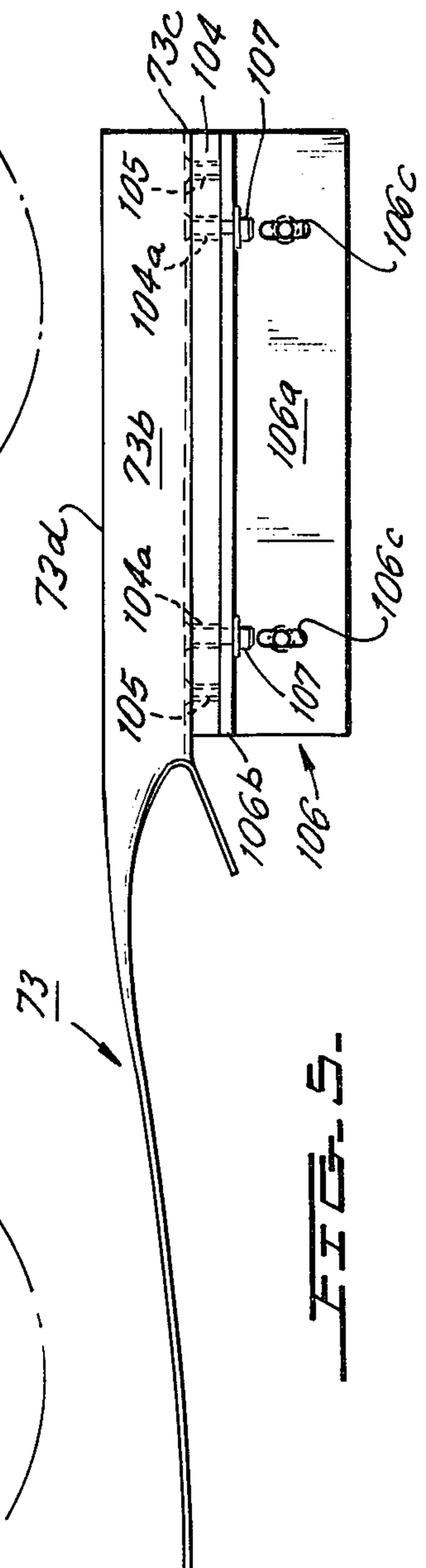


FIG. 5.

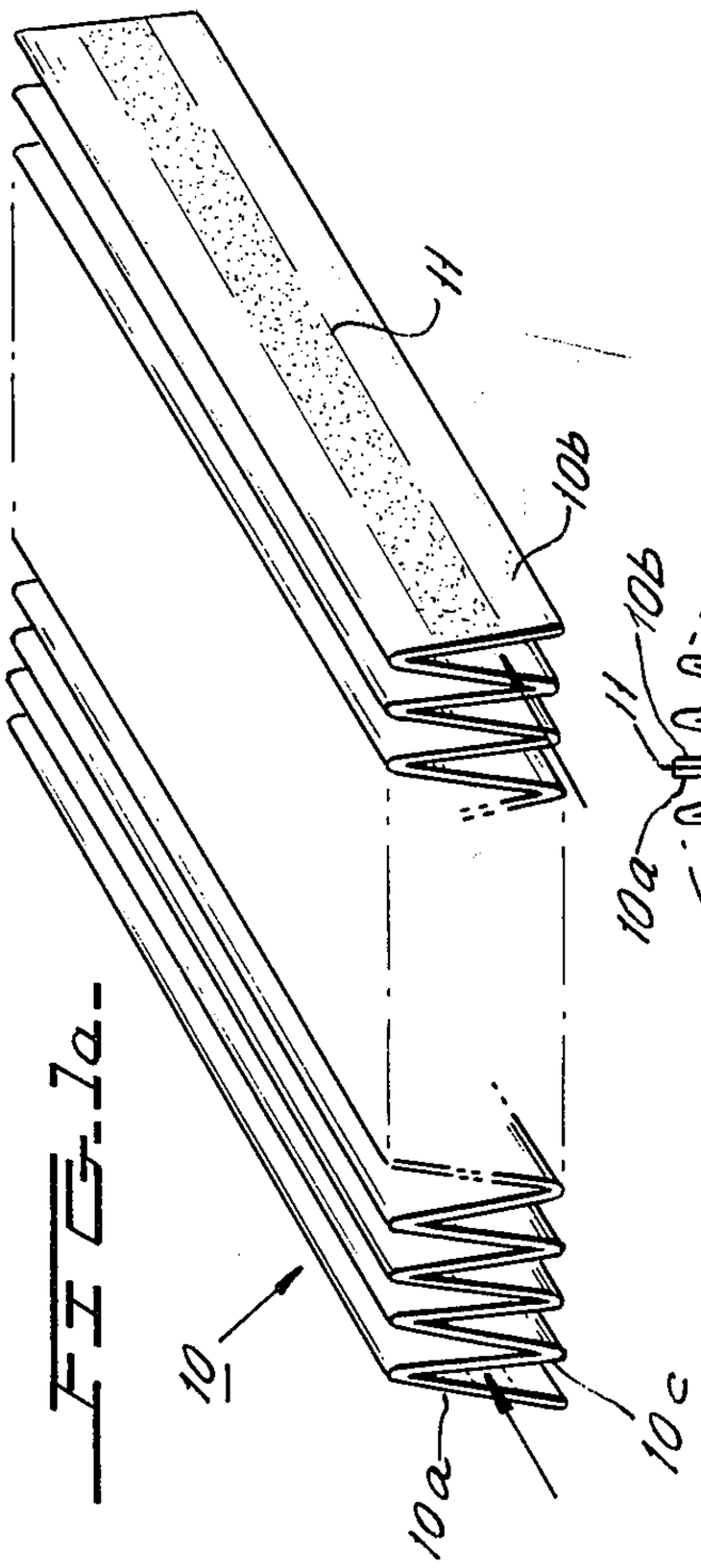


FIG. 1a.

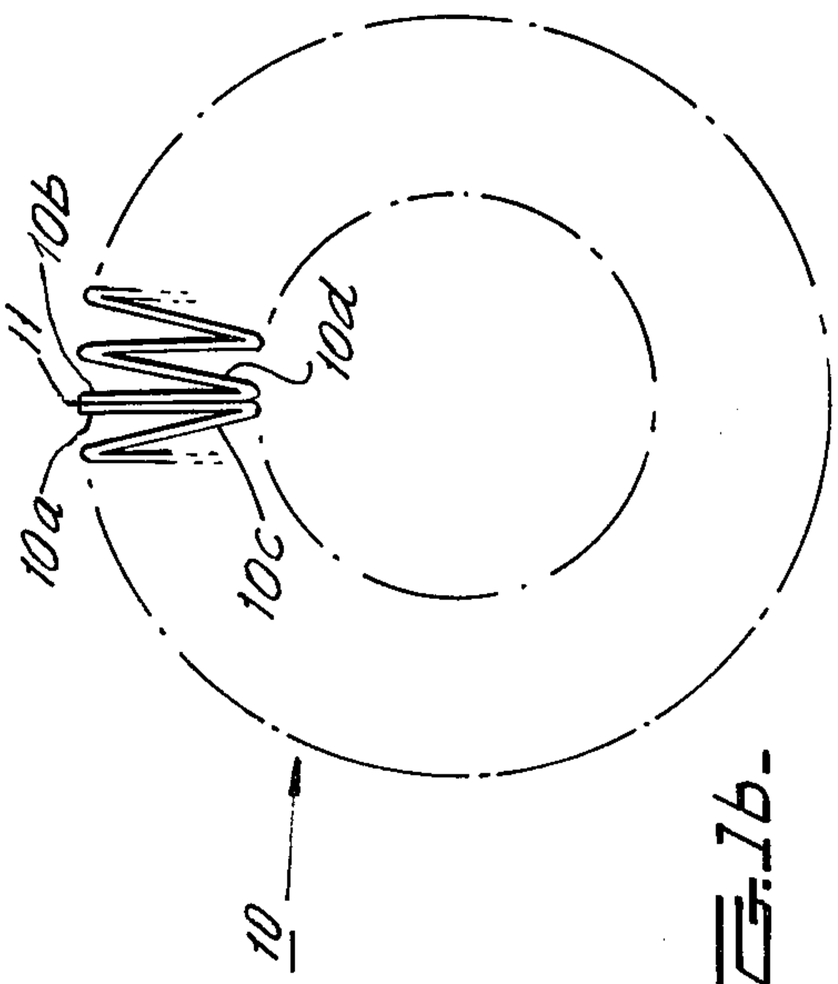


FIG. 1b.

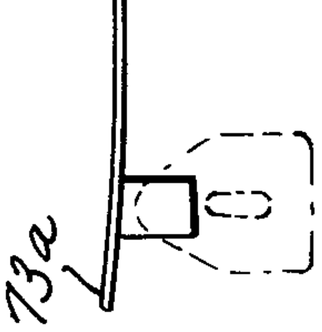
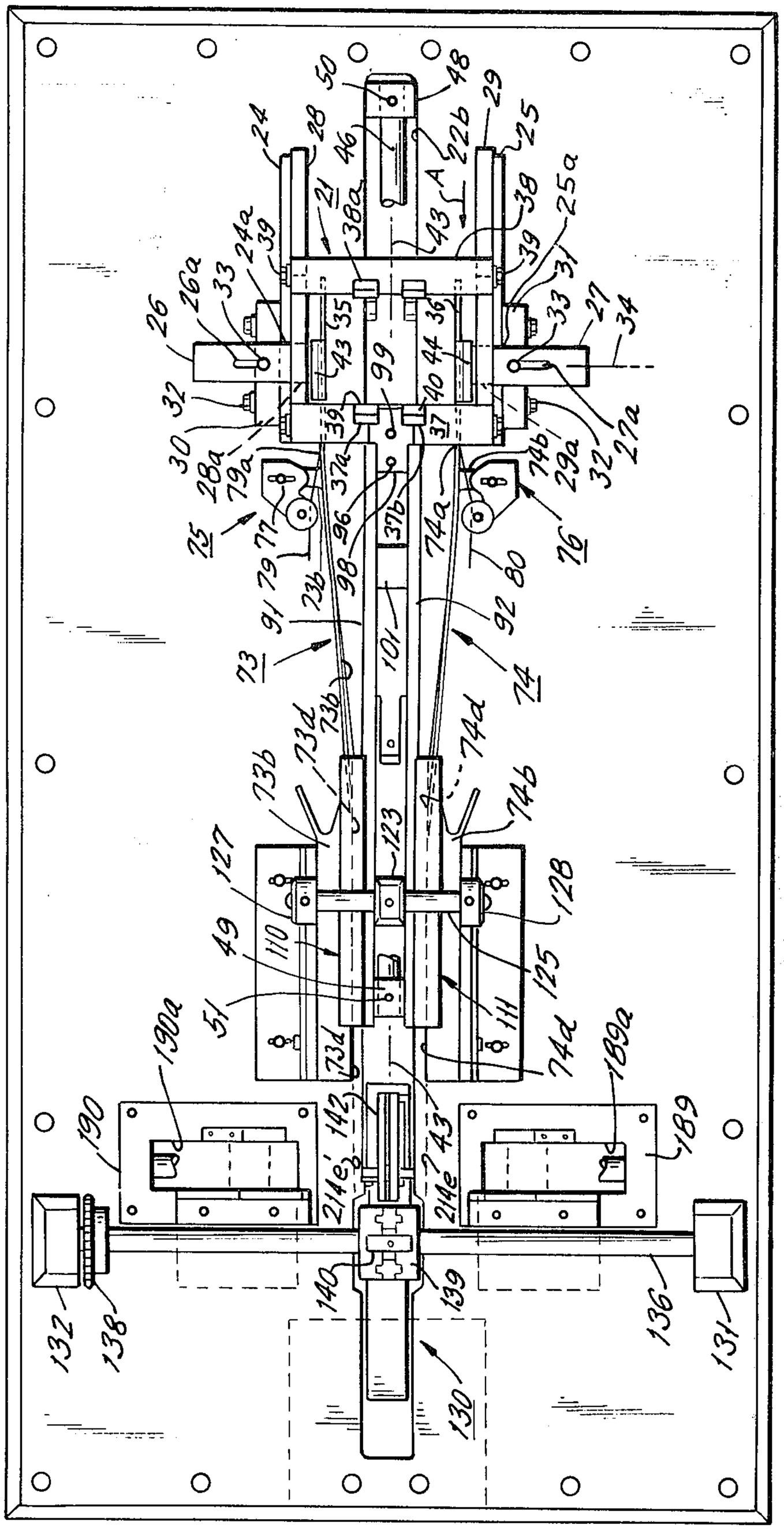


FIG. 2.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48
29
24
28
46
226
25
21
A
38a
43
38
25a
24a
39
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26
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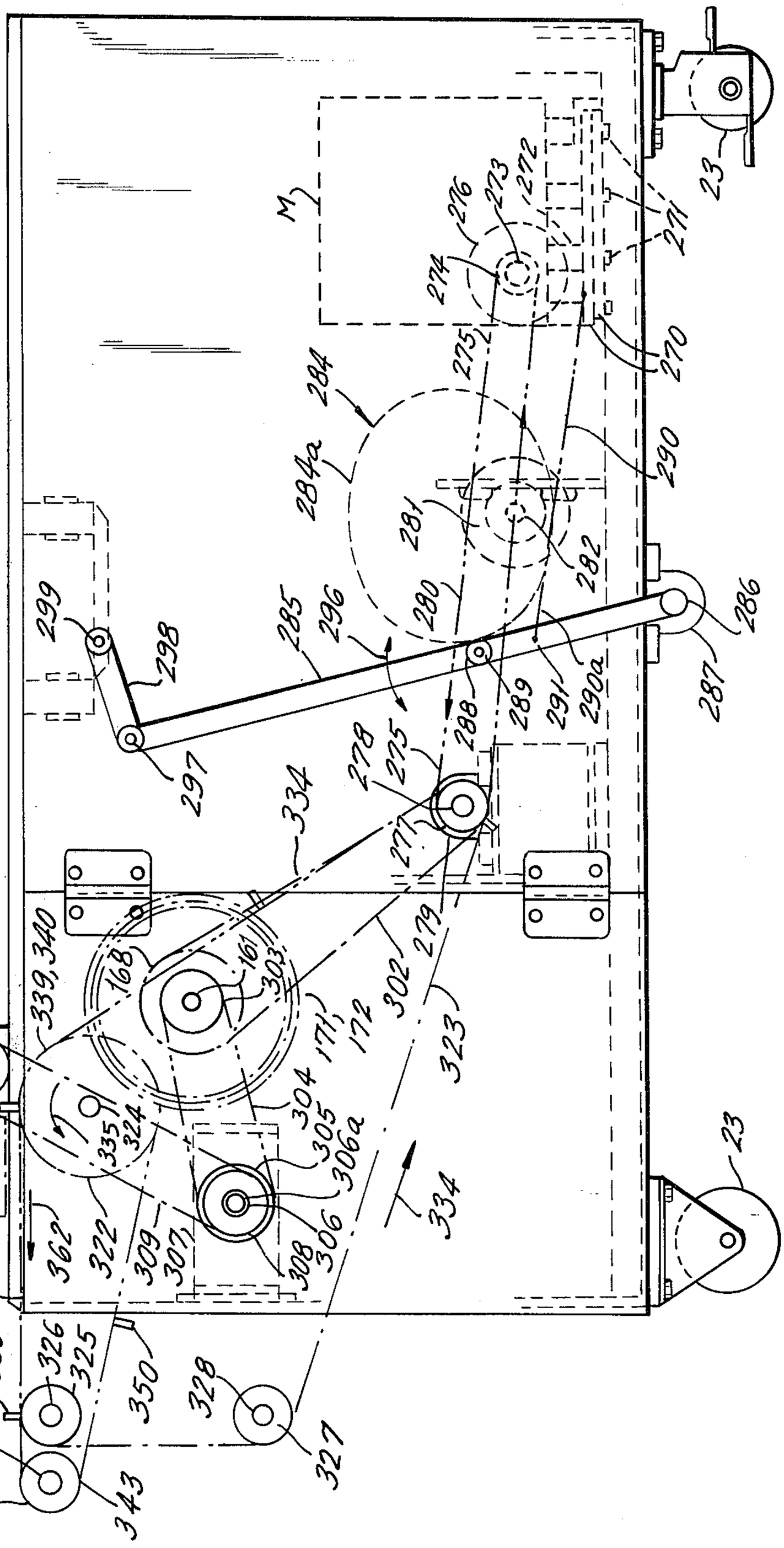
35
36
27
34
32
99
44
40
30
37
28a
79a
74b
29a
27a
75
77
96
37b
74a
76
79
98
80
91
23b
92
73
101
74
73b
74d
74b
123
127
128
49
110
125
51
111
189a
190a
190
142
214e'
43
214e
189
140
139
136
132
138
130
131

FIG. 2a.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F
23
271
272
273
274
275
276
270
284
284a
290
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285
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287
299
298
297
289
291
290a
288
278
334
277
279
339, 340
168
161
303
302
323
131
138
350'
141'
337, 338
362
322
309
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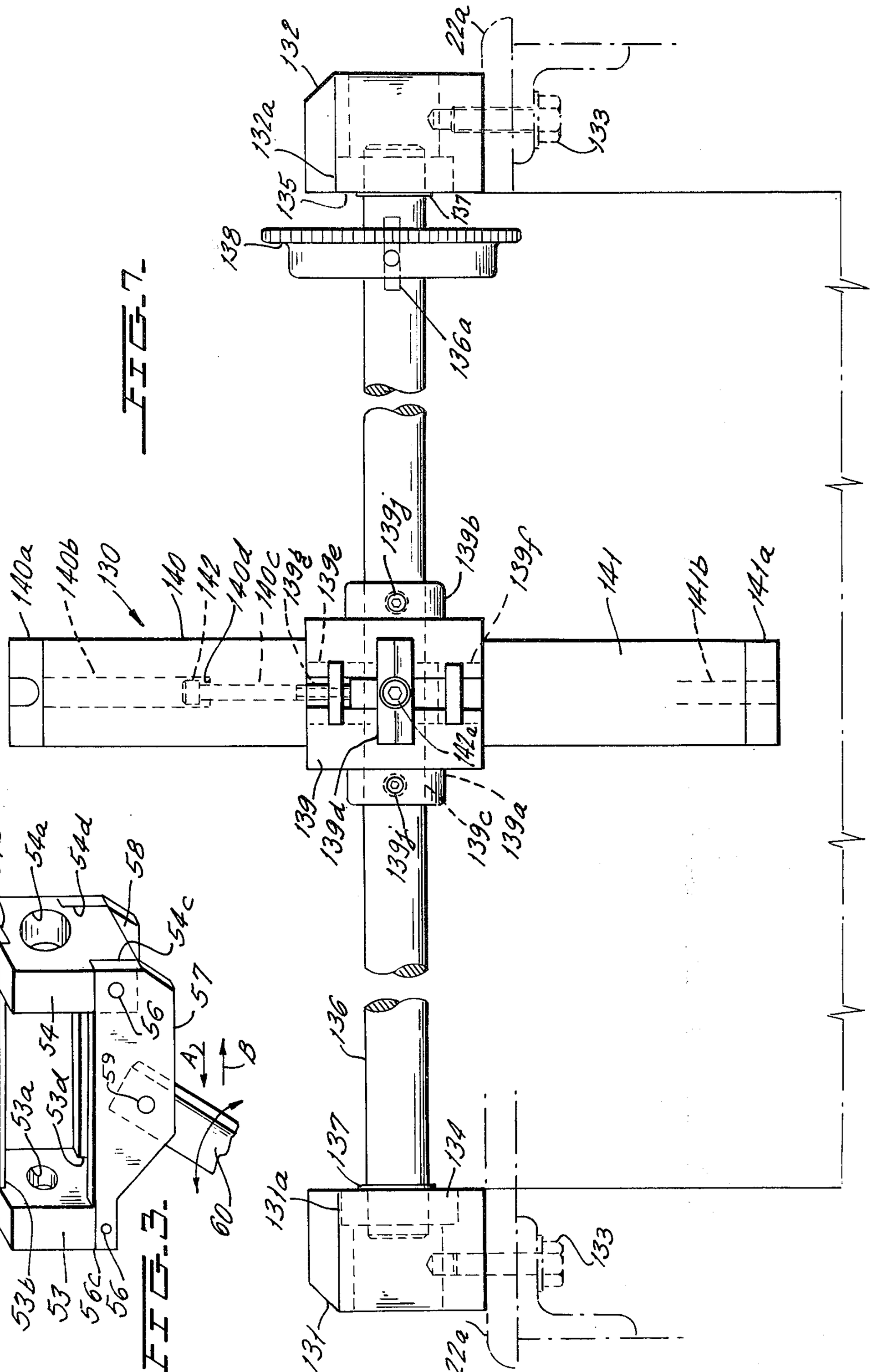
308
306
306a
304
305
171
172
324
335
344
350
326
325
328
327
342
343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132a
133
135
137
138
136a
139j
139b
139f
139e
139g
140a
140b
130
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140d
140c
139h
141
141b
141a
142a
139
139d
139i
139c
139a
136
131a
137
134
131
22a
133

FIG. 7.

54b
54a
54d
58
56
54c
57
55
54
56
59
A
A
B
53a
53d
60
52
53b
53
56c
56

FIG. 3.

FIG. 4a

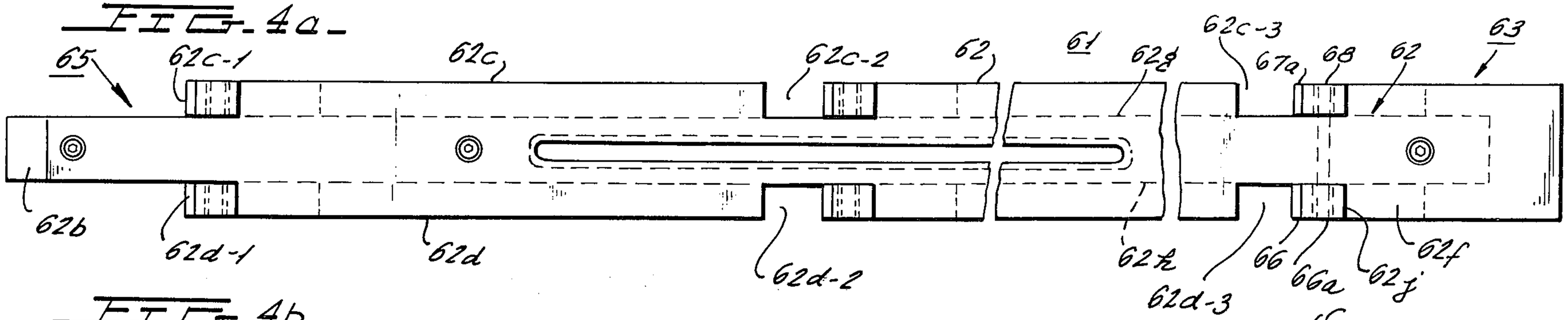


FIG. 4b

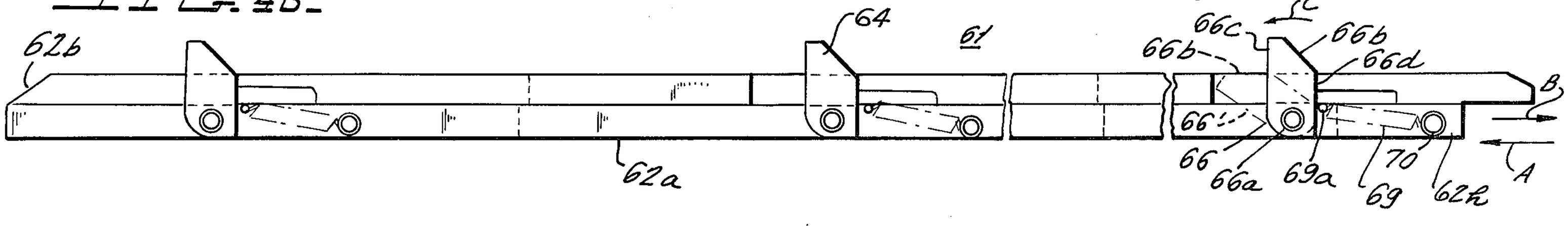


FIG. 5a

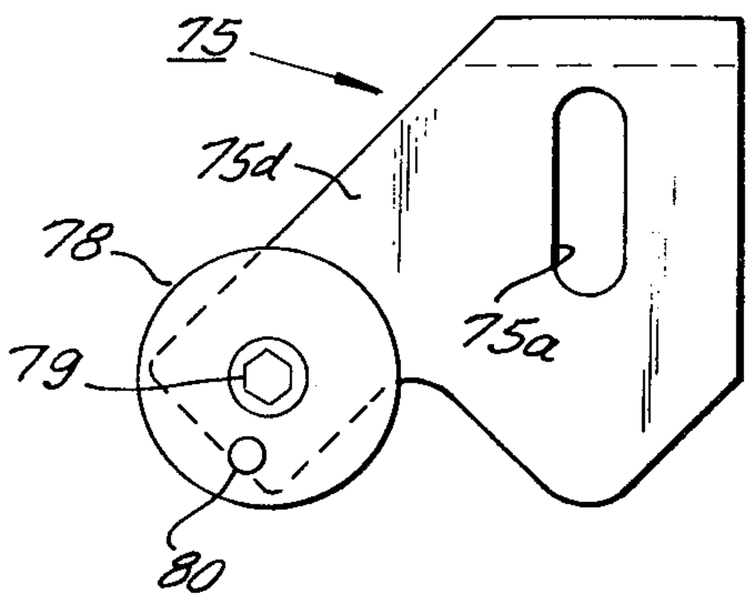


FIG. 5b

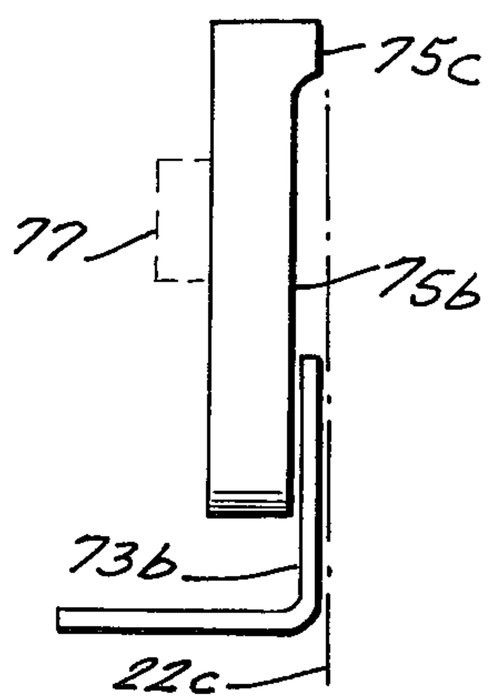


FIG. 5c

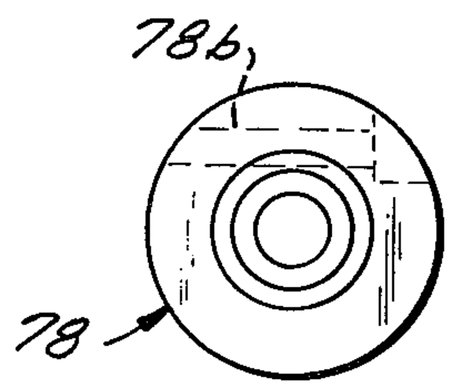
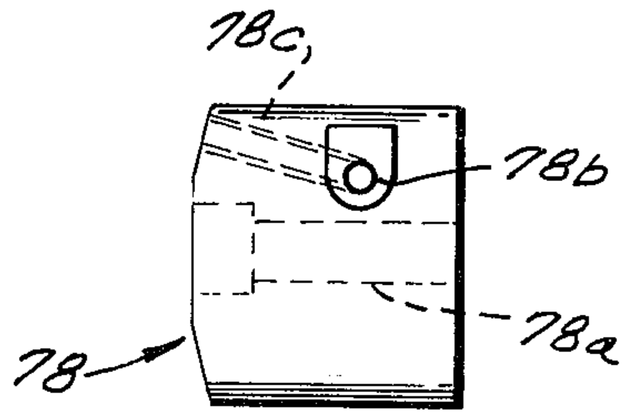
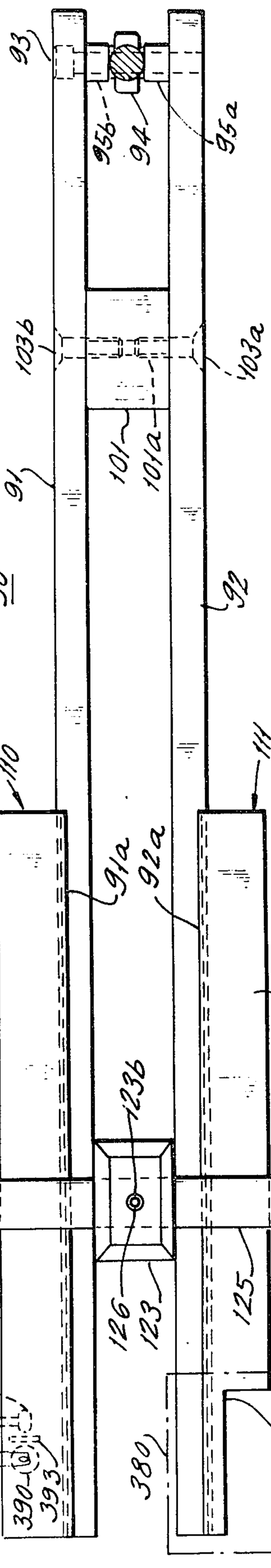


FIG. 5d

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95b
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95a
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103a
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101a
91
90
92
110
111
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91a
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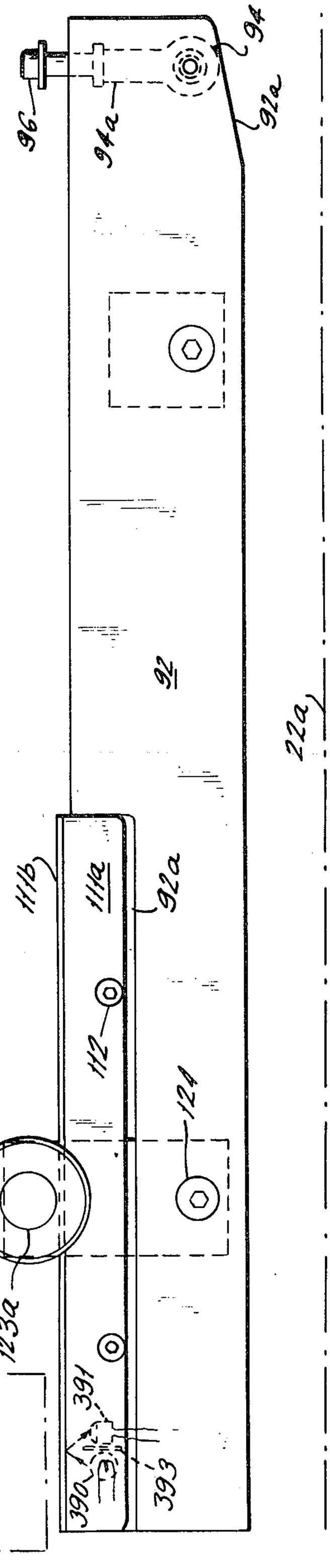
129
127a
123b
128a
127
126
123
125
128
129
TO 380
392
391
390
393
380
111c
FROM 392

FIG. 6a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111b
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112
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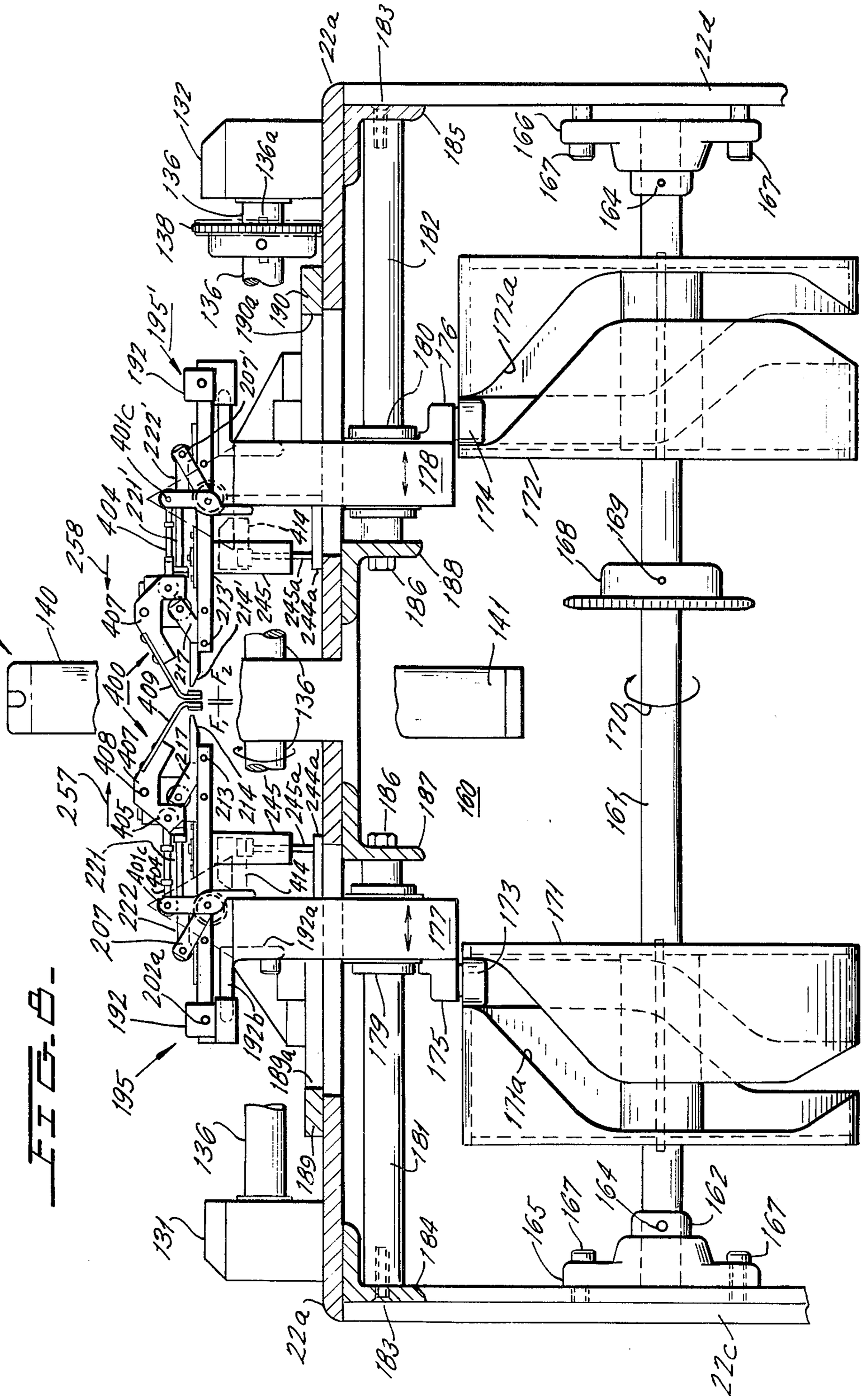
390
393
22a

FIG. 6b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183
122d
132
136a
185
166
136
167
164
167
138
182
136
190a
190
195'
172a
192
207'
180
176
401c'
222'
178
404
221'
174
172
258
414
168
169
130
140
407
213'
214'
245'
245a
244a
186
188
141
400
409
217
F2
136
408
401'
257
405
213
214
245
245a
244a
186
187
160
161
221
222
401c
404
414
207
173
171
192
202a
177
192a
179
175
195
192b
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184
165
167
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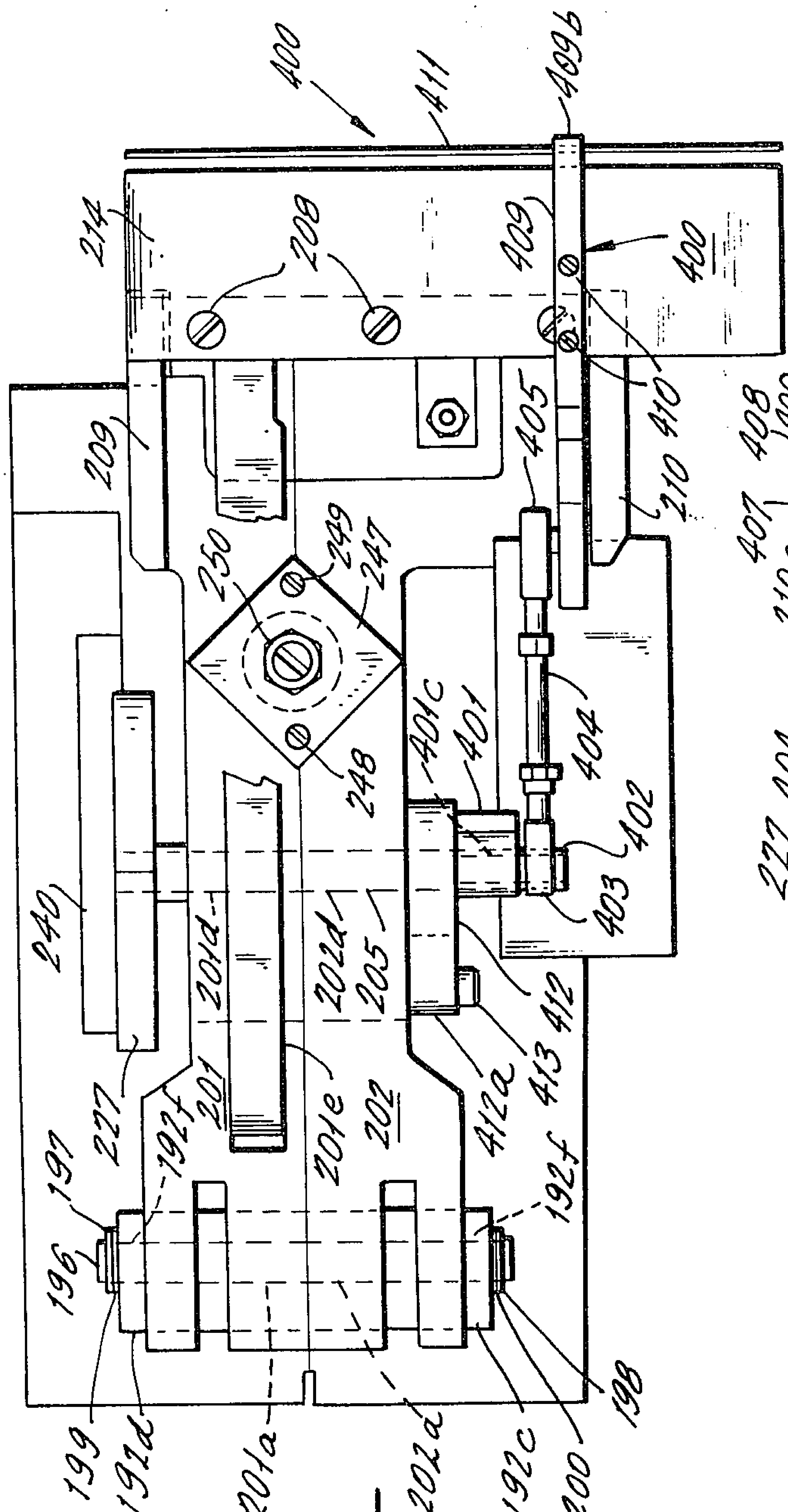
162
167
222a
183
22c

FIG. 8.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410
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405
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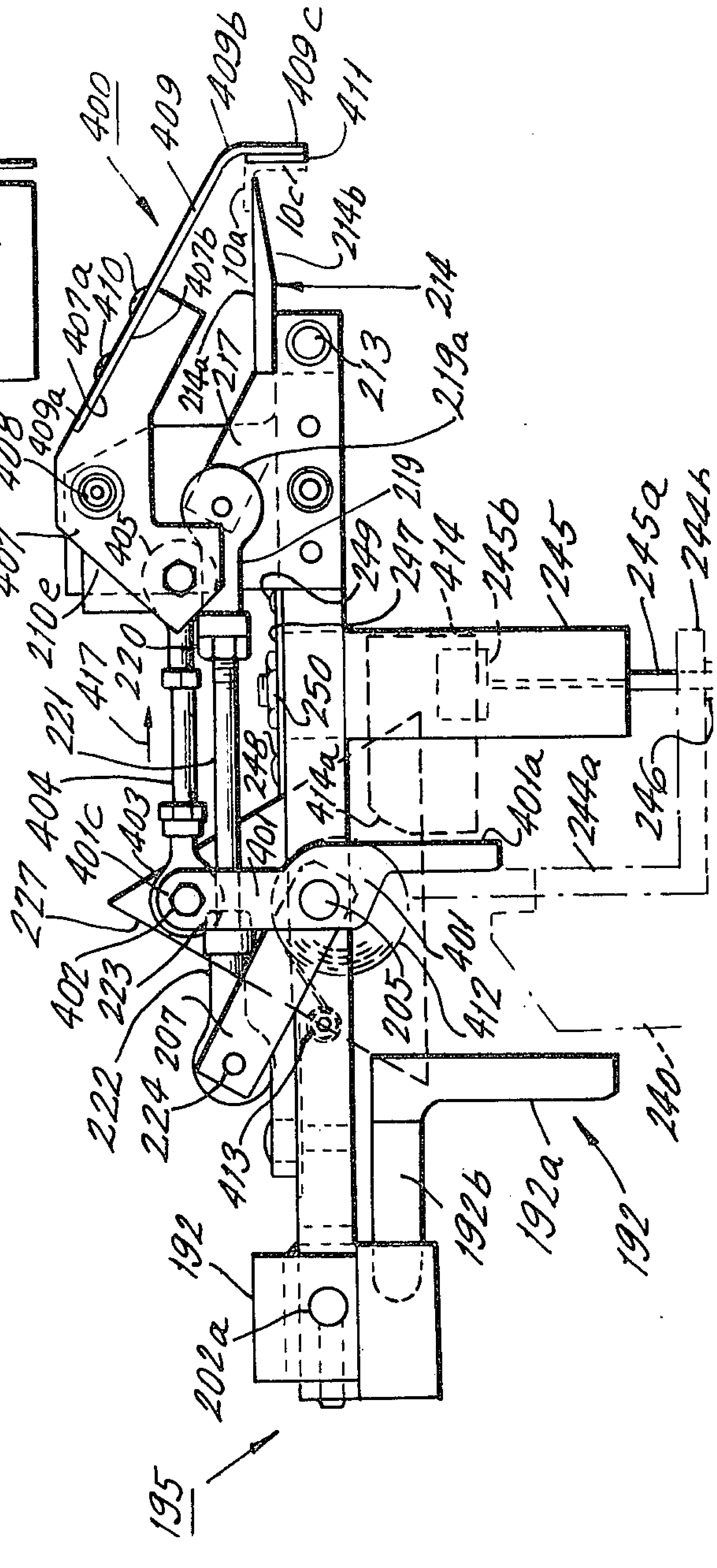
250
249
247
248
401c
401
404
402
403
240
201d
202d
205
412
227
201
201e
202
412a
413
197
192f
196
198
199
191d
201a
202d
192c
200

FIG. 9a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10c
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407
405
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210e
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245b
245
245a
244h
220
417
221
250
248
404
401c
403
401
414a
401a
244a
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205
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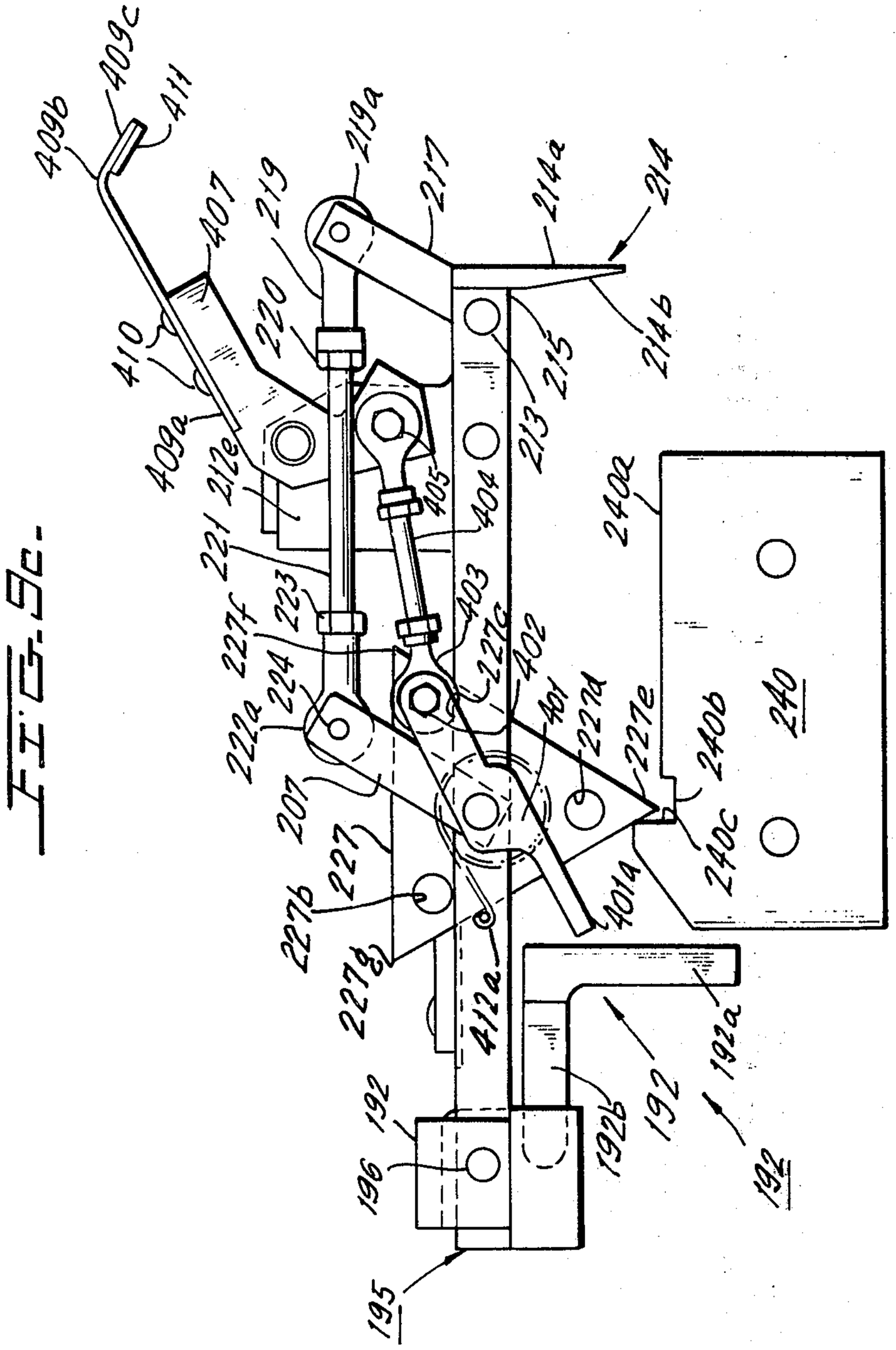
413
192
202a
192b
192a
240
195

FIG. 9b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409c
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409a
212e
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405
404
2402
223
227f
403
227c
402
224
222a
401
227d
227e
240b
240
207
227
227b
240c
227a
401a
227g
412a
192a
192
192b
196
192
195

FIG. 9c

METHOD AND APPARATUS FOR PRODUCING CLOSED LOOP ACCORDION PLEATED FILTERS

BACKGROUND OF THE INVENTION

Oil filters find widespread use in a wide variety of applications and are typically employed in lubricating systems. For example, in automobile engines, the oil utilized to lubricate the engine parts is continuously circulated through a closed loop path. Oil under circulation and leaving the engine is passed through an oil filter to remove any dirt or contamination therefrom so as to clean the oil returning to the engine. Such oil filters are typically comprised of a housing having input and output openings which are respectively coupled between the output and input of the engine being lubricated. Filter means typically comprised of a filter core having a generally annular shape is interposed between the input and output openings of the housing so that the oil entering the housing passes into the region encircled by the filter and than passes through the filter toward the output opening. The filter is formed of a material which enables the passage of the oil therethrough while collecting and capturing any contaminents contained in the oil.

A typical filter construction is comprised of a filter material of substantially elongated rectangular shape which is then pleated or otherwise folded in an accordion pleated fashion. The endmost flaps of the accordion pleated filter are then joined to one another by a suitable adhesive or other material to form the close looped accordion pleated filter core.

BRIEF DESCRIPTION OF THE INVENTION

The present invention is characterized by providing method and apparatus for fully automating the above-mentioned operation in which the method and apparatus employed and embodying the principles of the present invention, provides precise alignment between the flaps of the accordion pleated filter to be joined and which does not affect the integrity of the joinder once completed and further which is capable of producing more than 40 filters per minute in a continuous and fully automated operation.

The apparatus of the present invention comprises an infeed hopper which receives a plurality of accordion pleated filters stacked one upon the other. First pusher means pushes the bottom-most filter from the infeed hopper toward a pair of elongated guides which pass beneath the opposing flaps of the opposite ends of the filter as it is pushed downstream along the guides.

The guides are arranged to gradually converge toward one another with each guide member having a twist so as to orient the filter being moved therealong into a generally U-shaped configuration with the outermost flaps being oriented above the central portion of the accordion pleated filter and being gradually moved toward one another.

The first pusher means operates in a reciprocating fashion and, after having pushed the filter to the downstream end of the guide wires, reverses its direction to push the next filter in the infeed hopper along the guides.

Second pusher means then pushes the filter now at the downstream end of the guides onto a pair of spaced horizontally aligned slide members which support the outermost flaps of the accordion pleated filter and which position the flaps in closely spaced relationship.

A third pusher means pushes the outer flaps of the filter upon a pair of spaced parallel blades. As the filter moves onto the blades at least one of the flaps is coated with an adhesive automatically dispensed thereon in the presence of a passing filter. A rotatable paddle wheel having a plurality of arms indexes one of the arms into a position between and slightly beneath the pair of glue slide blades so that the paddle arm is positioned to be substantially encircled by the accordion pleated filter. The adhesive is preferably a stripe of hot melt material deposited upon the upper surfaces of at least one of the flaps which are supported by the glue slide blades, which hot melt material is heated as it is being dispensed.

Thereafter, the glue slide blades are moved toward one another so that their edges cause engagement between the edges of the flaps supported thereon. Simultaneously therewith the glue slide blades are rotated to press the confronting surfaces of the end flaps into firm engagement with one another to firmly join the flaps to one another.

The glue slide blades are momentarily kept in the pressed position for a time sufficient to enable the hot melt to at least partially set. Thereafter the glue slide blades are swung upwardly as they are being rotated toward the horizontal direction from their vertical orientation so as to lift the glue slide blades out of the pleats of the closed loop filter without affecting the integrity of the joinder.

The paddle wheel member is then indexed to place the next paddle arm into position for a gluing and joining operation. As soon as the paddle wheel arm containing a completed closed loop accordion pleated filter rotates through an angle of 180° from its initial core receiving position, stripper means provided along an outfeed conveyor strips the completed filter from the paddle wheel arm and onto the conveyor means. The operation of the above mentioned equipment is fully automated and is capable of producing more than **40** filters per minute in a continuous operating mode. The gluing and pressing station employs stop means for precisely aligning the flaps to be joined so as to assure perfect flap alignment during the gluing and pressing operation.

BRIEF DESCRIPTION OF THE DRAWINGS AND OBJECTS

It is therefore one object of the present invention to provide a fully automated method and apparatus for joining the end flaps of accordion pleated filters.

Still another object of the present invention is to provide a novel method and apparatus for forming closed loop accordion pleated filter members continually produced by apparatus which is adapted to position the end flaps of an accordion pleated filter adjacent one another, deposit a suitable hot melt thereon, accurately align the flaps to be joined and move and press the flaps to be joined into firm engagement to produce a good joinder therebetween, all of which operations are performed in a fully automated fashion.

The above as well as other objects of the present invention can best be understood from a consideration of the accompanying description and drawings in which:

FIG. **1***a* is a perspective view of a filter element in the form assumed when loaded into the feed hopper of FIG. **2.**

FIG. 1*b* is an end view of a filter which has been joined by the apparatus of the present invention.

FIG. 1*c* is an end view of the filter of FIG. 1*a*.

FIG. 1*d* is an end view showing the orientation of a filter during an intermediate stage of the operation of the apparatus disclosed in the present invention.

FIG. 2 is a top plan view of the apparatus of the present invention employed for accepting filters in the form shown in FIG. 1*a* to produce filters as shown in FIG. 1*b*.

FIG. 2*a* is an elevational view of the apparatus of FIG. 2 showing the drive mechanisms.

FIG. 3 is a perspective view showing the slide assembly for reciprocating the pusher assembly of FIG. 4.

FIGS. 4*a* and 4*b* are top and side views respectively, showing the pusher assembly of FIG. 2 in greater detail.

FIG. 5 is an elevational view showing one filter guide of FIG. 2 in greater detail.

FIGS. 5*a* and 5*b* are top plan and elevational views showing the hold down member of FIG. 2 in greater detail.

FIGS. 5*c* and 5*d* are top plan and elevational views respectively, showing wire guide mounting member of FIG. 2 in greater detail.

FIGS. 6*a* and 6*b* are top and elevational views showing a portion of the filter guiding assembly of FIG. 2 in greater detail.

FIG. 7 shows a detailed elevational view of the paddle-wheel assembly of FIG. 2.

FIG. 8 shows an elevational view of the blade assembly and paddle-wheel assembly employed in the apparatus of FIG. 2.

FIGS. 9*a* and 9*b* show top and elevational views respectively, of the left hand blade and guide assembly in the closed position.

FIG. 9*c* is a top view of one guide and blade assembly in the open position.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1*a* shows a perspective view of a typical filter **10** formed of a substantially rigid porous material having a characteristic of being capable of passing a lubricant such as oil therethrough while at the same time being adapted to capture particles or other contaminants within the oil to prevent the contaminants from re-entering the engine or other mechanical device being lubricated. The material typically employed for making such filters is any of the cellulose derived fibers, or any material that can be delivered in pleated formeither treated or untreated. However, any other material exhibiting similar characteristics may be employed.

The material, in the form of a flat elongated rectangular sheet, is pleated, pressed or otherwise operated upon to form the accordion pleated configuration of FIG. 1*a*. It should be understood that the technique employed to form the accordion pleated filter element **10** of FIG. 1*a* is beyond the scope of this invention and therefore any technique employed for producing a filter element of the type shown in FIG. 1*a* may be utilized without the necessity for any modification or alteration in the apparatus of the present invention.

The present invention teaches method and apparatus for accepting filter elements in the form shown in FIG. 1*a*, orienting them into an annular-shaped closed loop configuration and joining the outermost flaps of the filter element so as to form a closed loop accordion pleated filter element **10** as shown in FIG. 1*b*. The method employed herein is broadly comprised of the steps of accepting a filter element in the form shown in FIG. 1*a*, moving or otherwise orienting a filter element into an annular shaped configuration, depositing a suitable adhesive material such as, for example, a hot melt along at least one of the outermost flaps **10***a* and **10***b* of the filter element, one hot melt stripe **11** being shown deposited on the surface of flap **10***b* of FIG. 1*a*, precisely aligning flaps **10***a* and **10***b* and pressing the aligned flaps into firm engagement with one another so as to cause the hot melt to form a good joinder therebetween, all of the aforementioned steps being performed in a fully automated and continuous fashion.

FIG. 2 shows a top plan view of apparatus embodying the principles of the present invention and which is adapted to perform the aforementioned operations. The apparatus **20** shown in FIG. 2 is comprised of an infeed hopper **21** for receiving filter elements **10** stacked one upon the other. The infeed hopper **21** is mounted upon the top surface **22***a* of the machine frame which, in turn, is supported along its bottom edge by wheels **23** shown best in FIG. 2*a*. Although only two wheels are shown in FIG. 2*a* it should be understood that each corner of the substantially rectangular shaped machine frame is provided with a wheel of the type shown in FIG. 2*a*.

The infeed hopper is comprised of a pair of elongated base members **24** and **25** secured to top surface **22***a* so as to be arranged in substantially spaced parallel fashion. Each of the base members is provided with notches **24***a* and **25***a* for receiving the adjustably mounted slide arms **26** and **27** slidably received by notches **24***a* and **25***a*. A pair of elongated members **28** and **29** are secured to the top surfaces of base members **24** and **25**, respectively, and are provided with notches **28***a* and **29***a* which are respectively aligned with the notches **24***a* and **25***a* in base members **24** and **25** to form rectangular shaped openings for slide members **26** and **27**. Adapter blocks **30** and **31** secured to base members **24** and **25** by fastener means **32** are each provided with a tapped opening for receiving a threaded fastener **33** which passes through an elongated slot **26***a* and **27***a* in the slide arms **26** and **27** respectively, so as to allow for adjustment of the slide arms which may be moved toward or away from one another along the center line **34**. The inward ends of slide arms **26** and **27** have secured thereto a pair of elongated plates **35** and **36** arranged in a vertical or upright manner and having tapered upper edges arranged to enter into the gaps between flap **10***a*–**10***c* and **10***b*–**10***d* (see FIG. 1*c*) while maintaining the filter element between plates **35** and **36** under slight compression. The plates **35** and **36** preferably have smoothly polished side surfaces so as to minimize sliding friction between the filter elements and the plates for purpose to be more fully described. The plates **35** and **36** have their lower edges positioned immediately above surface **22***a*. The height of the plates **35** and **36** is designed to be slightly less than the height of the slightly compressed filter element located therebetween.

A pair of slide blocks **37** and **38** are joined to elongated base members **24** and **25** within notches provided therein so as to cooperate with plates **35** and **36** to define a rectangular perimeter of substantially the same length and width of a filter element as shown in FIG. 1*a*. Fasteners **39** secure the slide blocks **37** and **38** to the base members **24** and **25**.

Blocks **37** and **38** are each provided with a pair of notches **37***a* – **37***b* and **38***a* – **38***b* which are designed to

receive vertically mounted end guides **39, 40, 41** and **42,** respectively, which guides define the forward and rearward ends of the feed hopper.

A pair of elongated vertically aligned side guide posts **43** and **44** are secured to slide arms **26** and **27** respectively to define the left and right hand sides of the feed hopper. The length of the forward and rearward guides **39–42** and side guides **43** and **44** permit the hopper to be filled with a substantial number of filter elements arranged in a manner shown in FIG. **1***a* and with the pleats thereof being substantially parallel to the central axis of the machine as represented by phantom line **43** of FIG. **2.**

The feeder rack is designed so as to cause the filter elements to drop by gravity into the feed position whereby only a single filter element is adapted to rest upon surface **22***a* and plates **35** and **36** so that the top edge of the filter element in this position lies beneath the undersurfaces of slide blocks **37** and **38.** A filter element occupying this position may now be fed in the downstream direction by pusher means.

The pusher means utilized to eject a filter element from the feeder rack is mounted to reciprocate along the longitudinal axis of the machine. Top surface **22***a* of the machine housing is provided with an elongated opening **22***b*. An elongated shaft **46** shown in broken fashion for purposes of simplicity, has its right hand end mounted within a support block **48** and has its left hand end mounted within a support block **49.** Blocks **48** and **49** are each provided with tapped openings for receiving set screws **50** and **51** respectively for securing shaft **46** within the support blocks.

A slide assembly **52** shown in perspective view in FIG. **3** is slidably mounted upon shaft **46** and is comprised of first and second blocks **53** and **54** each provided with a central opening **53***a* and **54***a* respectively for slidably receiving shaft **46.** Blocks **53** and **54** are maintained in spaced parallel fashion by means of a top plate **55** secured within slots **53***b* and **54***b* by fastening means **56.** A pair of side rails **57** and **58** are secured within notches **53***c*–**53***d* and **54***c*–**54***d* of blocks **53** and **54** by fastening means **56.**

An elongated pin **59** extends through aligned openings in side rails **57** and **58** and is secured thereto by suitable fastening means (not shown for purposes of simplicity). Pin **59** is also threaded through an adjustable link **60** to be more fully described and which is in turn connected to a cam driven arm for reciprocally moving slide assembly **52** in the downstream and upstream directions as shown by arrows A and B along the shaft **46.**

A feeder slide assembly **61** is secured to the top plate **55** of slide assembly **52** as shown in FIG. **3.** FIGS. **4***a* and **4***b* respectively show top and elevational views of feeder slide assembly **61** which is comprised of an elongated one piece slide member **62.** The underside of **62***a* of member **62** rests upon top plate **55** and is secured tereto by suitable fastening means.

The downstream end of member **62** is provided with a beveled surface **62***b*. Sides **62***c* and **62***d* of member **62** are provided with notches **62***c*-**1, 62***c*-**2, 62***c*-**3** and **62***d*-**1, 62***c*-**2** and **62***d*-**3.** Each of the notches is provided to receive a pusher member wherein the pusher members are arranged in pairs as shown at **63, 64** and **65** respectively. Since all of the pusher members are substantially identical in both design and function, only one pusher member will be described herein in detail for purposes of simplicity.

Considering the pusher pair **63** comprised of pusher member **66** and **67** it can be seen that these pusher members are each provided with openings **66***a* and **67***a* for receiving a pin **68** which pivotally secures pusher members **66** and **67** to elongated slide **62.** The upstream edge of each member, such as member **66,** for example, is provided with a beveled surface **66***b* while the downstream edge, for example, edge **66***c*, is substantially flat.

Elongated slide **62** is provided with undercut notches **62***e* and **62***f* running substantially the entire length of slide member **62.** Pin **68** extends through the vertical walls **62***g* and **62***h* which define the elongated undercut shoulders **62***e* and **62***f*.

A helical spring **69** has its first end **69***a* secured to pusher arm **66** and has its opposite end secured to vertical wall **62***h* by fastening means **70.**

Keeping in mind the fact that the end of slide member **62** which is beveled at **62***b* is the forward end, when slide assembly **62** is moved in the direction shown by arrow B the beveled surfaces such as for example, the surface **66***b* will engage the forward or downstream edge of a filter element which will cause the pusher members to be pivoted in the direction shown by arrow C of FIG. **4***b* so that the beveled edge **66***b* will move to the dotted line position **66***b'*. Both pusher members **66** and **67** will remain in this position until they move past the upstream edge of a filter element in the feeder rack at which time biasing spring **69** will cause pusher member **66** to move to the solid line position shown in FIG. **4***b* so that its flat surface **66***c* will be positioned to the upstream side of a filter element.

When the slide assembly moves in the downstream direction shown by arrow A, pusher member **66** has its surface **66***d* resting against shoulder **62***j* of slide **62** which limits any pivotal movement of the pusher member, whereupon, as the slide assembly moves in the direction of arrow A, pusher members **66** will push the bottom-most filter element in the feeder rack in the downstream direction. It should be obvious that pusher members **66** and **67** operate in unison so that, when moving in the direction shown by arrow A both pusher members **66** and **67** serve to push the bottom-most filter element in the feeder rack **21** out of the feeder rack and in the downstream direction. Similarly when the slide assembly is moving in the direction shown by arrow B, both pusher members **66** and **67** will pivot downwardly to the position occupied by dotted pusher member **66'**.

As will be more fully described hereinbelow the first pair **63** of pusher members serve to eject a filter element from the feeder rack and to push this filter element a predetermined distance downstream at which time the reciprocating slide assembly then moves in the reverse direction to feed the next filter element from the feeder rack. The second pair **64** of pusher members will then be positioned to the upstream side of the filter element first previously moved downstream by pusher pair **63** so that the next time the slide arm **62** moves in the downstream direction shown by arrow A, the pusher member pair **64** will now push the filter element positioned downstream therefrom through the next phase of the machine and toward the third and final phase of the machine.

The third pusher member pair **65** after moving rearwardly in the direction shown by arrow B will then be positioned on the upstream side of the filter element just previously moved downstream by pusher member

pair **64** so as to push this filter element into the third and final stage of the machine.

The slide assembly **61** when moved to the rearward-most position, positions the pusher arm pair **63** to the right or upstream end of the bottom-most filter element in feeder rack assembly **21.** At this time, the slide assembly is moved in the downstream direction as shown by arrow A of FIG. **2** to push the bottom-most filter element out of the feeder rack and onto a pair of elongated guides **73** and **74.** FIG. **5** shows a perspective view of one of the guide members **73** whose upstream end is provided with a tapered tip **73***a*. The upstream portion of guide **73** is vertically oriented and is provided with an outwardly extended substantially horizontally aligned supporting tab **73***c* which is adjustably held down upon top surface **22***a* by means of a hold-down block **75.** Elongated guide **74** has a similar tab **74***b* adjustably held down upon surface **22***a* by a second hold-down block **76.** Since the guides **73** and **74** and hold-down blocks **75** and **76** are substantially identical (although mirror images of one another) only one of the guides and hold-down blocks will be described herein for purposes of simplicity. The outer surfaces of tips **73***a* and **73***b* engage the inner surfaces of guides **35** and **36** respectively (see FIG. **2**).

Hold-down block **75** is shown in detail in FIGS. **5***a* and **5***b*. Block **75** is provided with an elongated slot **75***a* for receiving fastening member **77** (see FIG. **2**) for adjustably securing block **75** to surface **22***a*. The underside **75***b* of hold-down block **75** has a short extension portion **75***c*. Undersurface **75***b* bears against the upper surface of tab **73***b* as shown best in FIG. **5***b*. When in this position, the short extension **75***c* serves to maintain undersurface **75***b* substantially parallel to surface **22***c* (shown in dotted fashion in FIG. **5***b*) so that good surface contact is made between undersurface **75***b* and tab **73***b*.

Hold-down block **75** is provided with a diagonally extending arm **75***e* provided with an opening for mounting a cylindrically-shaped wire holder element **78** which is also shown in detail in FIGS. **5***c* and **5***d*.

Wire holder **78** is provided with an axial opening **78***a* for receiving fastening member **79** which secures the wire holder to hold-down block **75.** Wire holder **78** is further provided with a substantially horizontally aligned opening **78***b* through which elongated wire **79** extends. Wire **79** is longitudinally adjustable and, once adjusted, is maintained in position by means of a set screw **80** threaded into tapped opening **78***c* which communicates with opening **78***b* so as to retain wire **79** in the desired position.

The tapered right-hand tip **79***a* of wire **79** is designed to abut against the tapered tip **73***a* of elongated guide **73.** As will be noted, a similar wire **80** is arranged in a similar fashion relative to end **74***a* of elongated guide **74.** The functions performed by wires **79** and **80** and wire guides **73** and **74** is as follows:

As the pusher member pair **63** of slide member **62** pushes the bottom-most filter element (which is arranged to be under slight compression in the feeder rack) out of the feeder rack, outermost flap **10***a* and the next adjacent pleat **10***c* pass on opposite sides of the wire **79** and guide portion **73***a* as shown best in FIG. **1***c*. In a similar fashion the flap **10***b* and pleat **10***d* pass on opposite sides of wire **80** and portion **74***a* of guide **74.** The pleats **10***a* and **10***c* and the pleats **10***d* and **10***e* are then caused to spread apart as the filter element is fed downstream. Due to the outwardly converging arrangement of wires **79** and **80,** pleat **10***a* is moved from a substantially vertical position toward a substantially horizontal position. Simultaneously therewith and due to the diverging arrangement of wire **80** and portion **74***a* of wire guide **74,** pleat **10***d* and flap **10***b* move from a substantially vertical orientation toward a substantially horizontal orientation.

The wire members **79** and **80** serve to spread the aforemention flaps and pleats sufficiently to enable the filter element to be appropriately slid onto guides **73** and **74.**

As the reciprocating slider assembly continues to move in the downstream direction as shown by arrow A of FIG. **2,** the substantially vertical orientation of guides **73** and **74** serve to retain the opposite ends of the filter element on the guides.

The guides are very gradually curved so as to change their orientation from vertical alignment at ends **73***a* and **74***a* toward horizontal alignment as shown for example by portion **73***d* of guide **73** (note FIG. **5** for example). It can be further noted as shown best in FIG. **2** that guides **73** and **74,** in addition to changing their orientation, gradually converge toward one another. Thus, as the pusher member pair **63** push the filter element along guides **73** and **74,** the filter element changes its configuration from that shown in FIG. **1***c* to the configuration shown in FIG. **1***d* wherein flap **10***a* is supported by the horizontally oriented portion **73***d* of guide **73** and wherein the pleat **10***d* is supported by the horizontally oriented portion **74***d* of guide **74.**

FIGS. **6***a* and **6***b* show top plan and elevational views respectively of the guide rail assembly positioned between guides **73** and **74.** Noting especially FIGS. **2, 6***a* and **6***b* the guide rail assembly **90** is comprised of a pair of rigid elongated plates **91** and **92** whose upstream ends are secured by fastening member **93** which has an eye bolt **94** mounted thereon. A pair of spacers **95***a* and **95***b* serve to maintain the right hand ends of elonated plates **91** and **92** in spaced parallel fashion. The upper portion **94***a* of eye bolt **94** is tapped to receive threaded fastener **96** which extends through an opening in adjusting block **98** (note especially FIG. **2**). Adjusting block **98** is secured to member **37** by fastening means **99.**

Another spacer **101** is positioned between plates **91** and **92** and cooperates with spacers **95***a* and **95***b* and eye bolt **94** to maintain plates **91** and **92** in spaced parallel fashion. Threaded fasteners **103***a* and **103***b* pass through openings in plates **91** and **92** and threadedly engage the tapped opening **101***a* in spacer **101** to secure spacer **101** between plates **91** and **92.**

Considering the elevational view of FIG. **6***b*, the central portion of the unfolded filter elements **10** for example, as shown in FIG. **1,** pass beneath the beveled edges provided at the upstream ends of members **91** and **92.** The beveled edge of **92***a* of member **92** is shown best in FIG. **6***b*. Thus, as the filter element end portions slide generally upwardly along the guides **73** and **74** (note FIG. **2**), the central portion of the filter element sliding therealong passes beneath the undersurfaces of members **91** and **92** so as to substantially encircle the members **91** and **92** while being fed in the downstream direction.

Considering FIG. **5** in conjunction with FIGS. **2, 6***a* and **6***b*, the downstream end of guide **73** shown in FIG. **5** has a horizontally oriented surface portion **73***b*. The outer edge thereof **73***c* is bent downwardly so as to extend in substantially the vertical direction. A verti-

cally aligned plate **104** has a downwardly extending vertically aligned flange **73***c* secured thereto by fastening means **105** which threadedly engage tapped openings in plate **104.**

Plate **104** is, in turn, secured to an L-shaped angle bracket **106** having a horizontally aligned arm **106***a* and a vertically aligned arm **106***b*. Fasteners extend through elongated openings **106***c* to secure angle bracket **106** to the surface **22***a* of the machine frame (see FIG. **2**). Arm **106***b* is vertically aligned and receives fastening means **107** which threadedly engage tapped vertical openings **104***a* in vertically aligned plate **104** to secure plate **104** against the downstream end of guide member **73** to the top surface of the machine frame. A substantially identical supporting structure is provided for guide member **74,** a detailed view thereof being omitted herein for purposes of simplicity.

Thus guide **73** has its upstream end **73***a* vertically oriented and member **73** gradually changes its angular orientation from vertical toward horizontal with the downstream portion **73***b* being horizontally oriented. The inner edge thereof, namely edge **73***d*, extends a spaced parallel distance from the horizontally aligned inwardly extending edge **74***d* of guide **74.**

Turning to a consideration of FIGS. **6***a* and **6***b* it can be seen that the plates **91** and **92** are each provided with depressions **91***a* and **92***a* respectively for positioning a pair of elongated L-shaped plates **110** and **111.** Noting especially plate **111** in FIG. **6***b* it can be seen that the vertically aligned arm **111***a* of member **111** is positioned within depression **92***a* and is secured to plate **92** by fastening means **112.** L-shaped plate **110** is secured to the outer surface of plate **91** in a similar fashion. The horizontally aligned arms **110***b* and **111***b* of L-shaped brackets **110** and **111** can be seen to extend outwardly from the central axis of the machine and as can best be seen from FIG. **1,** are arranged to lie a spaced parallel distance above the horizontally aligned portions **73***b* and **74***b* of guides **73** and **74.** It can thus be seen that L-shaped plates **110** and **111** cooperate with the horizontally aligned portions **73***b* and **74***b* of guides **73** and **74** to provide a guideway for the outermost flaps (or pleats, as the case may be) of a filter element as the filter element passes within the space provided between surfaces **73***b*–**110***b* and **74***b*–**111***b*.

Considering FIGS. **2, 6***a* and **6***b*, an additional spacer element **123** is positioned between plates **91** and **92** to maintain the parallelism of plates **91** and **92.** Fastening means **124** (only one of which is shown in FIG. **6***b*) passes through openings in plates **91** and **92** and threadedly engages tapped apertures in spacer **123** to secure plates **91** and **92** thereto. Spacer **123** is provided with a circular opening **123***a* through which shaft **125** extends. A tapped opening **123***b* is adapted to receive set screw **126** to secure shaft **125** to spacer **123.** A pair of members **127** and **128** have central openings for receiving shaft **125** and are provided with tapped openings **127***a* and **128***a* respectively for receiving threaded set screws **129** to secure members **127** and **128** to shaft **125.** Shaft **125** and members **127** and **128** serve as a means for adjusting the height of plates **110** and **111** in order to control the spacing between plate arms **110***b* and **111***b* and portions **73***b* and **74***b* of guides **73** and **74,** which is arranged to be adjustable to allow for the handling of filter elements of varying thicknesses.

The plate **111** is notched at **111***c* to provide a region for positioning the underside applicator surface of an adhesive applicator assembly **380** shown in dotted fashion in FIGS. **6***a* and **6***b*. The applicator dispenses a hot melt adhesive upon the upper surface of flap **10***a* as it passes the region of slot **111***c*. A light source **390** is positioned beneath plate **110** and directs light upwardly upon the underside of plate **110.** The light is reflected and impinges upon a photodetector **391** (separated from source **390** by opaque barrier **393**) as long as no filter is passing therebetween. As soon as the flap **10***b* of a filter element passes between plate **111** and light source **390,** the significantly reduced reflectivity of the flap material attenuates the amount of reflected light thereby reducing the light input to photodetector **391.** This results in a reduction in the electrical output signal developed by detector **391.** This condition is detected by detector circuit **392** (FIG. **6***a*) causing the glue applicator to be activated to dispense the hot melt upon flap **10***a* of the passing filter. The glue applicator may be any suitable hot melt device and the particular type employed is dependent only upon the needs of the user.

As was described hereinabove, the slide assembly **61** (see FIGS. **4***a* and **4***b*) having pusher pairs **63, 64** and **65** function in a manner whereby pusher pair **63** is utilized to eject a filter element from the feeder rack and push the ejected element a predetermined distance downstream. Member **62** then reverses its direction to push the next filter element from the feeder rack by means of pusher pair **63.** This time pusher pair **64** pushes the element previously ejected from the feeder rack further downstream along the guide members **73** and **74** causing the element to be pushed a further predetermined distance in the downstream direction.

Thereafter member **61** again moves upstream to eject a third element from the feeder rack by pusher pair **63** while pusher pair **64** moves the second element ejected from the feeder rack further downstream. The downstreammost pusher pair **65** then pushes the first element ejected from the feeder rack into the final gluing and forming station at which time a coating of hot melt is deposited on the flaps and the flaps are then pressed firmly together to provide a good joinder therebetween.

The final pusher pair **65** ejects the filter element whose flaps are positioned between angle arms **110***b* and **111***b* and guide portions **73***b* and **74***b*, toward a "paddle-wheel" filament advancing assembly **130** shown best in FIGS. **2** and **7.** FIG. **2** shows a top plan view and FIG. **7** shows an elevational view looking in the direction from the left-hand end of the machine toward assembly **130.**

Assembly **130** is comprised of a pair of mounting brackets **131** and **132** secured to top surface **22***a* by fastening means **133.** Each of the members **131** and **132** is provided with an annular-shaped opening **131***a* and **132***a* for receiving ball-bearing assemblies **134** and **135** respectively. A shaft **136** has its free ends journalled within bearings **134** and **135.** Snaprings **137** serve to retain bearings **134** and **135** within the annular openings **131***a* and **132***a*. A sprocket **138** is mounted to shaft **136** and is locked against rotation by means of a keyway **136***a*. As will be shown and described in detail hereinbelow, a chain engages the sprocket **138** for rotating freewheelingly mounted shaft **136.**

A substantially cubic shaped rigid block **139** provided with collars **139***a* and **139***b* has a central opening **139***c* receiving shaft **136.** Set screws **139***j* engage tapped openings in collars **139***a* and **139***b* to lock member **139** to shaft **136** so as to rotate therewith. Cubic

shaped member **139** is provided with four openings for receiving "paddle" members to be more fully described. Only three of the openings **139***d*, **139***e* and **139***f* are shown in FIG. **7** for purposes of simplicity. Each of these openings respectively receive a "Paddle-arm" only three such arms **140, 141** and **142** being shown in FIG. **7** for purposes of simplicity. The paddle-arms **140** and **141** each have tapered free ends **140***a* and **141***a* and are further provided with elongated axially aligned openings **140***b* and **141***b* for receiving fastening members **140***e* (only one of which is shown in FIG. **7** for purposes of simplicity). Opening **140***b* narrows to a smaller diameter opening **140***c* to provide a shoulder **140***d* against which the head of fastening member **142** rests. The fastening member threadedly engages a tapped opening **139***g* in member **139** to firmly secure the paddle-arm **140** thereto.

It should be understood that four such arms arranged at 90° intervals are secured to member **139,** which arms are moved in an incremental or stepwise fashion so as to be indexed through an angle of 90°. Assembly **130** is operated in a manner such as to position one arm **142** (also see FIG. **2**) substantially in the horizontal plane so as to be aligned with the central axis **43** of the apparatus. Arm **142** is positioned to lie above the central portion of the filter element positioned between arms **110***b*–**73***b* and **11***b*–**74***b* and is further positioned to lie below the outermost flaps of the filter element. The downstream pusher pair **65** when moving in a direction shown by arrow A of FIG. **2** (i.e. in the downstream direction) pushes the filter element further downstream so as to substantially encircle arm **142.**

In addition to moving a filter element toward the paddle-wheel assembly, the final pusher pair **65** also moves the filter element toward the filter fold assembly **160** shown in FIG. **8.** The filter fold and glue slide assembly **160** is comprised of a shaft **161** having its ends journalled within bearings **162** and **163** secured to shaft **161** by set screws **164.** The bearings are mounted within brackets **165** and **166** secured to the machine frame sidewalls **22***c* and **22***d* respectively by fastening means **167.** The faces of block **139** perpendicular to their associated arms act as the stop means for aligning filter flaps fed to the blades.

A paddle-wheel drive sprocket **168** is secured to shaft **161** by set screw **169** and is driven by a drive chain (to be more fully described) to rotate in the direction shown by arrow **170.**

A pair of barrel cams **171** and **172** are secured to shaft **161** so as to rotate therewith. The barrel cams are each provided with a cam configuration adapted to reciprocally move the glue slide members towards and away from one another in a manner to be more fully described. The cam contours **171***a* and **172***a* form a slot in the cylindrical surface of each cam to slidably receive a rotatably mounted cam follower roller. The freewheelingly mounted rollers **173** and **174** are shown as being positioned within the slots of the cams **171***a* and **172***a*. Rollers **173** and **174** are respectively freewheelingly mounted to brackets **175** and **176** which in turn are secured to slides **177** and **178.** Each of the slides are provided with ball bushings **179** and **180** which slidably receive shafts **181** and **182.** The outer ends of shafts **181** and **182** are secured by fastening means **183** to angle brackets **184** and **185** provided in the upper corners of the machine frame. The inner ends of shafts **181** and **182** are secured by fastening means **186** to angle brackets **187** and **188.**

The cams **171***a* and **172***a* reciprocally move cam followers **173** and **174** simultaneously outwardly and inwardly in a reciprocating fashion. This movement is imparted to slides **177** and **178** which slide along shaft **181** and **182.**

Slides **177** and **178** extend in the upward vertical direction and pass through elongated rectangular shaped slots **189***a* and **190***a* provided in rectangular shaped slide guides **189** and **190** respectively. The elongated rectangular shaped openings in the slide guides have a width substantially equal to the width of the slides **177** and **178** and members **189** and **190** are preferably formed of a plastic material having a low coefficient of sliding friction so as to minimize wearing between the slides **177** and **178** and the slide guides **189** and **190.**

The outer surfaces of slides **177** and **178** are each provided with depressions **177***a* and **178***a* for seating downwardly extending arms **192** and **193** of the glue slide assemblies **194** and **195** respectively.

FIGS. **9***a* and **9***b* show top plan and side elevational views respectively of glue slide assembly **195** with the blade thereof being shown in the compression position. FIGS. **9***c* and **9***d* show top plan and side elevational views respectively of the glue slide assembly **194** with the blade thereof being shown in the filter flap receiving position.

For purposes of simplicity the component parts of glue slide assembly **195** will be described herein in detail, it being understood that the component parts and operation of glue slide assembly are substantially identical thereto, all elements of assembly **194** relating to elements of assembly **195** being designated in FIG. **9***c* with "primes."

As shown in FIGS. **9***a*–**9***c* glue slide assembly **195** comprises a substantially L-shaped support bracket having vertically aligned arm **192***a* and substantially horizontally aligned arm **192***b* provided with a pair of upwardly extending projections **192***c* and **192***d* which are provided with axially aligned openings **192***e* and **192***f* for receiving shaft **196.** Snap-rings **197** and **198** secure washers **199** and **200** as well as shaft **196** into position. Shaft **196** also passes through openings **201***a* and **202***a* in elongated rigid members **201** and **202** which pivot about shaft **196** in a manner to be more fully described. Members **201** and **202** are secured to one another by shaft **196.** Members **201** and **202** are further provided with co-aligned openings **201***d* and **202***d* which slidably receive shaft **205.** Member **201** is provided with a rectangular shaped opening **201***e* for receiving an arm **207.**

Blade mounting brackets **209** and **210** are secured to the outer ends of members **201** and **202.** Brackets **209** and **210** each have an outwardly extending arm portion having an opening which serves as a pivotal mount for shaft **213** of the glue slide blade. Bracket **210** has an upright arm **210***e* for supporting the blade guide **400** as will be more fully described. Openings in the brackets **209** and **210** pivotally support the free ends of shaft **213** which is rigidly secured to blade **214** by means of weldments such as, for example, the weldment **215.** Washers **216** are provided to reduce wearing between the blade support brackets **209** and **212** and shaft **213.**

The blade **214** can best be seen in FIG. **9***b* as having a flat surface **214***a* and a bevelled surface portion **214***b* to form a tapered free end. A link **217** is rigidly secured (such as, for example, by welding) to shaft **213** at a point intermediate its end and extends generally diago-

nally upward and to the right. Link **217** has a pair of bifurcated arms **217***a* and **217***b* which are provided with openings for receving a fastener **218** to secure one end **219***a* of a rod holder **219.** End **219** is provided with a ball-bearing opening **219***b* (see FIG. **9***a*) to reduce wearing at the knee formed between member **219** and link **217.** Rod holding member **219** is provided with an adjustable nut **220** for threadedly engaging rod **221.** Another rod holding member **222** is provided with a similar adjustable nut **223** to adjust the relative spacing between rod holders **219** and **222.** The opposite end of rod holder **222** is similarly provided with a ball-bearing rod end **222***a* which is positioned between the bifurcated arms **207***a* and **207***b* of link **207.** These bifuracated arms are provided with co-aligned openings for receiving fastener **224.**

Link **207** is rigidly secured to shaft **205** so as to pivot about the axis of shaft **205** as a result of any rotation imparted to shaft **205,** which rotation will occur in a manner to be more fully described.

Considering FIGS. **9***a* and **9***b* it can be seen that with link **207** in the position shown, blade **214** is oriented in the horizontal direction. With link **207'** in the position shown in FIG. **9***c* the blade **214'** can be seen to be in the vertical position. Although views **9***a*–**9***b* show blade **214** in a position different from view **9***c*, these orientations are shown for purposes of explaining the extreme positions of the blades and, it should be understood that the blades move in synchronism so that both blades **214** and **214'** (see FIG. **8**) are always in the same orientation, i.e., when blade **214** is horizontally oriented, blade **214'** is also horizontally oriented.

Shaft **205** is further provided to freewheelingly mount a triangular shaped cam member **227** provided with an opening **227***a* for receiving shaft **205.** Openings **227***b*, **227***c* and **227***d* are provided for weight reduction of the triangular shaped cam member. A snap-ring **229** holds cam **227** on shaft **205** and a hollow cylindrical spacer **231** and washer **232** serve to hold the triangular shaped cam **227** a spaced distance from the confronting edge of member **202.**

The opposite end of shaft **205** has a rocker arm **401** rigidly secured thereto by means of opening **401***c* which receives shaft **205.** A threaded opening receives set screw **237** to lock rocker arm **401** to shaft **205.**

Rocker arm **401** has a lower portion **401***a* which cooperates with the upper surface **411***b* of a stationary rigid member **414** for the purpose of rotating shaft **205** and lever **207** and hence moving blade **214** to the vertical position.

The triangular cam member **227** described hereinabove cooperates with the cam surface provided along the top edge of the rigid member **240.** The top edge of **240***a* thereof is provided with a notch **240***b* which cooperates with the apices **227***e*, **227***f* and **227***g* of triangular cam **227** in a manner to be more fully described.

Slide **177** has an angle bracket **244** whose arm **244***a* is secured to the right hand surface of slide **177** and whose horizontally aligned arm **244***b* has the piston rod **245***a* of a dashpot **245** secured thereto by fastening means **246.** Piston rod **245***a* is mechanically coupled to piston **245***b* mounted within the body of the dashpot, which body is secured to members **201** and **202** by means of a square shaped bracket **247** and fastening means **248, 249** and **250.** Fastening means **250** functions to control the rate of release of pressure within the piston cylinder.

The blade guide assembly **400** comprises a rocker arm **401** pivotally mounted upon and locked to shaft **205** (FIGS. **9***a*, **9***b* and **9***c*). The lower end **401***a* of arm **401** is vertically aligned when in the position shown in FIG. **9***b*. The upper end **401***b* of rocker arm **401** has an opening **401***c* for receiving a pin **402** extending from eyelet **403.** Eyelet **403** is secured to one end of link rod **404,** whose opposite end is secured to eyelet **405.** The opening in eyelet **405** receives pin **406** which extends into swingable arm **407.** Arm **407** is pivotally mounted to the upright portion **212***e* of member **212** by pin **408.** Surface **407***a* has a notched portion **407***b* upon which rests the mounting portion **409***a* of guide support arm. Fasteners **410** secure guide support arm to swingable arm **407.** The free end of guide support arm is bent at **409***b* so that its end portion **409***c* extends substantially vertically downward when the blade and guide assembly is in the position shown in FIG. **9***b*.

An elongated guide plate **411** is secured to guide support arm portion **409***c*.

A torsion spring **412** is spirally wound about shaft **205** and has its inner end secured to rocker arm **401.** The outer hook shaped end **412***a* of spring **412** is secured to member **202** by fastener **413** (note both FIGS. **9***a* and **9***b*). A cam **414** is secured to bracket **244***a* (see FIG. **8**) and has a beveled corner **414***a*.

With the blade and guide assembly in the position shown in FIG. **9***b* a filter core is advanced in the downstream direction towards the blade and guide assembly. The flap **10***a* and the pleat **10***c* enter into the gap between horizontally aligned blade **214** and vertically aligned guide plate **411.** Guide plate **411** prevents the flap **10***a* from slipping off of blade **214.** As the barrel cams **171–172** rotate (see FIG. **8**), the left and right hand blade assemblies move towards one another.

Rocker arm **401** engages cam **414** causing rocker arm **401** to rotate in the clockwise direction, moving link rod **404** to the right as shown by arrow **417** (FIG. **9***c*). The right-hand movement of link rod **404** causes member **407** to rotate counter clockwise about pin **409** whereupon guide support arm **409** and guide plate **411** are swung upwardly and away from blade **214** to clear the region between the left and right-hand blades and enable the blades to come together to firmly press end flaps **10***a* and **10***b* together. The glue applied to flap **10***a* is thus brought into contact with flap **10***b*.

The clockwise rotation of rocker arm **401** causes torsion spring **412** to become tightly wound about shaft **205.** The blades **214** remain together (due to the barrel cam configuration) for an interval sufficient to cause the glue to at least partially "set." The barrel cams then cause the blade assemblies to move apart thereby moving rocker arm **401** away from cam **414,** thus enabling torsion spring **412** to "unwind" and hence rotate rocker arm **401,** shaft **205** and lever **207** in the counter clockwise direction. This causes blade **214** to rotate counter clockwise moving from the vertical position back to the horizontal position.

Guide plate **411** is rotated in the clockwise direction swinging downwardly from the horizontal position to the vertical position in preparatory to receiving the next filter member to be joined.

The operation of the glue slide assembly is as follows:

As was described hereinabove, the downstream-most pusher pair **65** (see FIGS. **4***a* and **4***b*) pushes a filter element whose outermost flaps rest upon surfaces **73***b* and **74***b* of guide **73** and **74,** toward the blades **214** and **214'** which initially are horizontally aligned and are

moved inwardly toward one another by the barrel cams so as to have their free edges **214***c* and **214***c'* substantially in alignment with the edges **74***d* and **73***d* respectively (see FIG. **2**). At this time one paddle arm of the paddle wheel assembly is horizontally aligned so as to have the filter element being moved toward the paddle arm substantially encircle the paddle arm. The face of block **139** aligns the filter flaps.

The photodetector **391** detects the presence of a filter as it moves towards the blade assemblies to automatically dispense glue upon one of the flaps. If desired two dispensers may be employed to coat both of the flaps to be joined.

The motor drive (which is described in more detail hereinbelow) rotates shaft **161** by means of a chain engaging sprocket **168.** The barrel cams **171** and **172** are thus rotated in unison to cause the cam followers to move from the filter receiving position (with the baldes **214** and **214'** in horizontal alignment) toward the compression position. The inward movement of cam followers **173** and **174** is imparted to slides **177** and **178** which causes the entire glue slide assemblies **194** and **195** to move toward one another.

Just before the inward movement of assemblies **194** and **195,** the trip members **236** and **236'** are respectively positioned to the left and to the right of rigid members **238** and **238'** having cam surfaces **238***a* and **238***a'*. Torsion springs **412** and **412'** respectively encircle shafts **205** and **205'** and have their inner ends secured to shafts **205** and **205'** and/or rocker arms **401.** The free outer ends of the torsion springs are secured to the side edges of members **202** and **202'** by fasteners **413** and **413'**. These torsion springs serve to maintain members **236** and **236'** in substantially vertical upright positions. As the barrel cams **171** and **172** move the cam followers **173** and **174** and hence the slides **177** and **178** inwardly, the edges **236***b* and **236***b'* engage the rounded corners **238***c* and **238***c'* thereby causing members **236** and **236'** to rotate in the direction shown by arrows **253** and **253'**. Since the members **236** and **236'** are rigidly locked to shafts **205** and **205'**, shafts **205** and **205'** also rotate in the respective directions shown by arrows **253** and **253'**. The links **207** and **207'** are also rigidly secured to shafts **205** and **205'** and hence rotate in the respective directions shown by arrows **253** and **253'**. This causes the rods **221** and **221'** to move in the respective directions shown by arrows **257** and **257'** causing the links **217** and **217'** to rotate about shafts **213** and **213'** from the direction shown in FIG. **9***b* toward the direction shown in FIG. **9***c*. This rotational movement occurs simultaneously with linear movement of the assemblies **194** and **195.** The tips of blades **214** and **214'** come close to touching one another so as to engage the apices of the filter element flaps to be joined and then move in the vertically aligned direction so as to firmly press the end flaps F_1 and F_2 together between blades **214** and **214'**. The blade guides **411** and **411'** move in the manner previously described to hold the filter flaps on the blades as the filters are fed thereto and swing out of the way when the blades come together.

As was previously described, immediately prior to a filter element being pushed onto the horizontally aligned blade members **214** and **214'**, glue or hot melt dispensing means **380** functions to dispense a layer of hot melt upon the confronting surface F_1 of one of the filter flaps to be joined. Thus, when the filter flaps F_1 and F_2 are firmly pressed together in the position shown in FIG. **8,** the hot melt deposited on the flap F_1 is caused to spread and join the two confronting flap surfaces.

The cam configurations **171***a* and **172***a* provide sufficient dwell time with the blades **214** and **214'** in the position shown in FIG. **9***c* which dwell time is sufficient for the hot melt to at least partially "set." This dwell time occurs even though the barrel cams **171** and **172** continuously rotate.

Immediately after the dwell time, the cam configurations of barrel cams **171** and **172** move the cam followers **173** and **174** and hence the slides **177** and **178** away from one another in order to separate the blades from the finished filter core.

The triangular cam members **227** and **227'** cooperate with their associated cam surfaces provided along the top edge of members **240** and **240'** in order to prevent the just joined flaps from being pulled apart prematurely. The operation is as follows:

One side of the triangular cam members **227** and **227'** slides along surface portion **240***a* until apices **227***e* and **227***e'* abut the vertical edges **240***c* and **240***c'* of notches **240***b* and **240***b'* respectively. As the apices **227***e* and **227***e'* come into engagement with vertical edges **240***c* and **240***c'*, they are caused to rotate about shafts **205** and **205'** upon which they are freewheelingly mounted. This rotation causes the plates **201–202** and **201'–202'** to pivot about pivot pins **196** and **196'** respectively, causing these plate pairs to be lifted and hence causing the blades **214** and **214'** to be lifted substantially upward and out of the spaces between the pleats of the filter core element just completed.

The blades also simultaneously begin to pivot from the vertical position shown in FIG. **9***b* toward the horizontal position shown in FIG. **9***c* so that the blades move generally upward and out of the spaces between the pleats of the completed filter core as well as being rotated.

As the asemblies **194** and **195** move still further outward, the triangular cam members **227** and **227'** rotate until another flat surface engages the top edge of the cam surface members **240** and **240'**. Since this action causes the plates **201–202** and **201'–202'** to swing generally downwardly in a rather rapid fashion, the dashpot assemblies **245** and **245'** serve to "cushion" the abrupt drop of plates **201–202** and **201'–202'**.

Although the finished filter core is now completely released from the blades **214** and **214'**, it should be understood that the filter core is now a continuous closed loop member which fully encircles one arm of the paddle wheel assembly thereby preventing the filter core from being removed therefrom. The driving linkage between the single motor source of the apparatus and the paddle wheel driven sprocket **138** (see FIGS. **2** and **8**) steps the paddle wheel assembly through an angle of 90° so that the arm containing the just completed filter core is now in a vertcially upright position. The next arm of the paddle wheel assembly is moved into the horizontal position in readiness for receiving the next filter core to be completed. Once this filter core is completed, the paddle wheel assembly is again rotated through an angle of 90° causing the first completed filter core in the upright position to be moved to the horizontal position. A core stripper assembly to be more fully described in connection with FIG. **2***a* strips or removes the completed core element therefrom and conveys the completed core element to the next location or to a bin or other depository for use in a subse-

quent assembly operation in the production of filter assemblies.

FIG. 2*a* shows, in simplified fashion the linkages between the primary drive source of the apparatus and all other components thereof. The motor M is mounted in the lower right-hand corner of the machine housing (relative to FIG. 2*a*) and is secured upon mounting plates **270** by fasteners **271.** Cylindrical resilient members **272** provide a resilient cushioning mount for the motor. The motor output shaft **273** is provided with a drive sprocket wheel **274** having a closed loop chain entrained about sprocket **274** and meshing with the teeth thereof. A mounting bracket **276** journals the free end of shaft **273** within a bearing provided in bracket **276** which is secured to the interior side of the machine frame sidewall **22***d*. The chain **275** is entrained about sprocket **274** and a sprocket **277** mounted upon jack shaft **278** which has its free ends journalled within bearings provided along the interior surface of the machine upright sidewalls. A second sprocket **279** is secured to jack shaft **278** and has a chain **280** entrained about sprocket **279** and a sprocket **281** mounted upon a shaft **282** which extends across the width of the machine and has its free ends journalled in suitable bearings (not shown for purposes of simplicity). A cam member **284** is mounted upon shaft **282** and is rigidly secured thereto. For purposes of simplicity, only the cam surface **284***a* of cam member **284** has been shown. A cam follower arm **285** has its lower end pivoted about shaft **286** mounted along the underside of the machine frame by a pair of brackets. only one bracket **287** is shown in FIG. 2*a* for purposes of simplicity. A roller **288** is rotatably mounted to cam follower are **285** by pin **289.** A tension spring **290,** which may for example, be an elongated helical spring, has a first end thereof **290***a* secured to cam follower arm **285** by pin **291.** The opposite end of the tension spring is mounted to plate **270** by a pin **293.** Tension spring **290** causes the cam follower arm **285** to normally be urged in the clockwise direction about shaft **286** as shown by arrow **296.** Roller **288** rides around cam surface causing cam follower arm **285** to swing clockwise and counterclockwise respectively, about its pivot shaft **286.** The upper end of cam follower arm **285** is pivotally coupled by pin **297** to arm **298** whose free end is coupled by fastener **299** to the feeder slide assembly **52** (see FIG. **3**). Thus, as the cam **284** rotates, cam follower arm **285** follows the cam surface to reciprocate the feeder slide assembly **52** in a reciprocating fashion moving first upstream, then downstream, then upstream and so forth in order to feed filter elements through the various stages of the apparatus.

As was described hereinabove, close looped chain **275** rotates sprocket **277** and hence jack shaft **278.** Rotation of jack shaft **278** is imparted to a second sprocket (not shown for purposes of simplicity) provided on jack shaft **278** which has a closed loop chain **302** entrained about the aforesaid second sprocket and about a sprocket **168** mounted upon shaft **161,** which sprocket and shaft are also shown in FIG. **8.** This shaft carries the barrel cams **171** and **172** which were described hereinabove.

Shaft **161** is also provided with a second sprocket **303** having a closed loop chain **304** entrained about sprocket **303** and further entrained about sprocket **305** which is mounted to rotate shaft **306.** Shaft **306** is in actuality an input shaft to a clutch assembly **307** which has an output shaft **306***a* shown superimposed upon shaft **306.** In actuality the shafts **306** and **306***a* extend through diametrically opposed sides of clutch assembly **307.** A sprocket **308** is mounted upon the output shaft **306***a* of clutch assembly **307** and has a closed loop chain **309** entrained about sprocket **308** and about sprocket **138** entrained upon shaft **131.** Sprocket **138** and shaft **131** are also shown in FIGS. **2** and **8** and serves as the sprocket and shaft for operating the paddle wheel assembly **130.** The operation of this drive mechanism is as follows:

The rotation of the motor output shaft is imparted to the clutch assembly through the drive chain described hereinabove so as to rotate the input shaft **306** of the clutch assembly. The clutch assembly is designed to enable its output shaft **306***a* to rotate through an angle of 90° and immediately thereafter to be disengaged from input shaft **306** for a time interval sufficient to complete a filter forming operation. The clutch assembly again becomes engaged upon completion of a filter element to again rotate the paddle wheel assembly **130** through an angle of 290° thereafter becoming disengaged for a time interval sufficient to complete the next succeeding filter joining operation of the clutch assembly continues for each succeeding filter element.

Jack shaft **278** is provided with a third sprocket (not shown for purposes of simplicity) having a closed loop chain **323** entrained about the third sprocket, a sprocket **322** entrained about shaft **324,** a sprocket **325** mounted upon shaft **326** and a sprocket **327** mounted upon shaft **328.** Chain **323** moves in the direction shown by arrow **334** so as to rotate sprocket **322** about shaft **324** in the direction shown by arrow **335.** A second pair of chains **337** and **338** forming a conveyor, are entrained about a pair of sprockets **339** and **340** mounted upon shaft **324** and are also respectively entrained about a pair of sprockets **342** and **343** mounted upon shaft **344.** Each of the chains **337** and **338** are provided with pusher members **350** arranged at spaced intervals and in pairs about the conveyor chains **337** and **338.** The upright stripper pair **350′** is shown positioned just upstream of a filter element positioned on paddle wheel arm **141′**. Chains **337** and **338** are continuously moved and are driven in the direction as shown by arrow **362** along the upper run thereof causing the stripper pair **350′**, for example, to push against the upstream edge of a completed filter F to strip the filter from paddle wheel assembly arm **140** and cause the filter to be deposited upon the surface of chains **337** and **338.** The filters move along the upper run of chains **337** and **338** and are delivered to a suitable depository or other utilization means in readiness for the performance of subsequent assembly steps in the manufacture of filter assemblies employed in lubricating systems.

It can be seen from the foregoing description that the present invention provides a novel, high speed automatic apparatus for folding and gluing filter cores and the like at speeds not heretofore attainable and with the joined flap being accurately aligned.

Although the present invention has been described in connection with a preferred embodiment thereof, many variations and modifications will now become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.

What is claimed is:

1. A method for folding and joining an accordion pleated filter having a pair of downwardly facing end

flaps at opposite ends thereof comprising the steps of:
lowering the filter upon a pair of spaced elongated guides to rest the folds adjacent the end flaps upon said guides;
moving the lowered filter in a feed direction along the twisted downstream ends of said guides to move said end flaps to a horizontal position;
moving the filter off the downstream end of said guides and sliding the end flaps upon a pair of spaced horizontally aligned blades respectively aligned with the downstream ends of said blades;
depositing an adhesive upon one of said end flaps; and
simultaneously swinging the blades downwardly and moving said blades towards one another to firmly press the outer surfaces of said end flaps together whereby said end flaps are joined together by said adhesive means.

2. The method of claim **1** further comprising the steps of:
simultaneously swinging said blades upwardly and moving said blades apart after the adhesive has at least partially "set."

3. The method of claim **2** further comprising the step of simultaneously lifting the blades upwardly as they are separating to prevent the separating blades from moving the joined flaps apart.

4. The method of claim **2** further comprising the step of removing the completed filter from the region between the separating blades preparatory to moving the next filter onto said blades.

5. Apparatus for joining the end flaps of an accordion pleated filter members and the like comprising:
a pair of elongated guides each having upstream and downstream ends;
said guides being vertically aligned at their upstream ends and having a gradual twist provided therein intermediate the upstream and downstream ends whereby said downstream ends are horizontally aligned;
means for moving said filters onto the upstream ends of said guides and downstream along said guides whereby the gaps between a spaced pair of pleats in said members are supported by said guides and whereby the end flaps are gradually moved from vertical orientation to horizontal orientation as the members move along the length of said guides;
means adjacent the downstream ends of said guides for applying an adhesive to one of said passing outer flaps;
a pair of blade means each being aligned with the downstream ends of said guides for receiving and supporting said outer flaps as a filter member passes downstream from the guides;
said blade means having a pair of rotatably mounted blades;
means for reciprocally moving said blades towards and away from one another;
means responsive to the reciprocal movement for rotating the blades from a horizontal orientation, when the blades are apart, to a vertical orientation, when the blades come together, to press the outer flaps into firm engagement and thereby cause the flaps to be joined to one another by said adhesive.

6. Apparatus for joining the end flaps of accordion pleated filter members and the like comprising:
a hopper for receiving a vertical stack of filter members:
the base of said hopper having a pair of spaced uprights adapted to be captured in the gaps between a spaced pair of pleats in said filter member;
means for pushing the bottom-most filter out of said hopper in a forward feed direction towards the downstream end of the apparatus thereby causing the next filter in the stack to drop into the base of the hopper;
a pair of elongated guides having their upstream ends adjoining the ends of associated ones of said uprights to receive and slidably support a filter member;
said guides each having a gradual twist along their length to move the outer flaps of the filter from a vertical orientation to a horizontal orientation as the filter moves downstream;
means adjacent the downstream ends of said guides for applying an adhesive to one of said passing outer flaps;
a pair of blade means each being aligned with the downstream ends of said guides for receiving and supporting said outer flaps as a filter member passes downstream from the guides;
said blade means having a pair of rotatably mounted blades;
means for reciprocally moving said blades toward and away from one another;
means responsive to the reciprocal movement for rotating the blades from a horizontal orientation, when the blades are apart, to a vertical orientation, when the blades come together, to press the outer flaps into firm engagement and thereby cause the flaps to be joined to one another by said adhesive.

7. The apparatus of claim **1** wherein said apparatus further includes an indexable paddle wheel assembly having a plurality of arms for sequentially positioning each arm along the path of movement of the filters so as to be captured in the center of the filter as it is fed to said blade means;
means for rotating the said arm captured by a completed filter to a position removed from the blade means and simultaneously positioning the next adjacent arm along said path of movement to receive the next filter to be joined.

8. The apparatus of claim **7** further comprising means for removing each completed filter from a paddle wheel arm.

9. The apparatus of claim **1** wherein each of said blade means further includes blade guide means including a plate moveable from its associated vertical orientation adjacent the horizontally oriented blade to a diagonal orientation remote from its associated vertically oriented blade;
means for moving the blade guide means from said vertical orientation to said diagonal orientation as said blades move together and for moving the blade guide means from said diagonal orientation to said vertical orientation as the blades move apart;
said blade guide means preventing a filter flap from slipping off to its associated blade when the guides are in said vertical orientation.

10. The apparatus of claim **7** comprising means for urging the center portion of the filter downwardly as the filter is advanced to assume a substantially U-shaped configuration to facilitate encirclement of a paddle-wheel arm by the filter.

11. The apparatus of claim **1** wherein said applicator means further comprises means for sensing the passage

of a filter to activate said applicator means to dispense adhesive.

12. The apparatus of claim **1** further comprising means for lifting said blade means as they begin to move apart to lift said blade means away from the filter and prevent the joined flaps from being pulled apart.

13. Apparatus for joining the end flaps of an accordion pleated filter or the like, comprising:

a linear guide;

first and second slide means slidably mounted along said guide;

drive means for reciprocally moving said slide meams together and apart;

each of said slide means having rotatable blade means movable between a first flap receiving and supporting position and a second flap gluing position;

rotary drive means for moving said blade means towards said first position as said first and second slide means move apart and for moving said blade means towards said second position when said first and second slide means come together;

means for moving end flaps of said filter onto said blade means when in said first position;

means for depositing an adhesive upon one of said flaps, whereby said flaps are pressed together and joined when said blade means are moved to said second position.

14. The apparatus of claim **8** further comprising means for lifting said blade means as they begin to move apart to lift said blade means away from the filter and prevent the joined flaps from being pulled apart.

15. The apparatus of claim **13** wherein each slide means further comprises rotatable guide means; movable between a first position adjacent its associated blade means and a second position away from said blade means;

means coupled to said rotary drive means for moving said rotatable guide means towards said first position when said blade means are separating to aid in supporting the filter flaps on said blade means and for moving said guide means towards said second position to enable said blade means to be pressed together.

16. The apparatus of claim **14** wherein said slide means comprises a first member movable by said drive means;

a second elongated member pivotally joined to said first member;

a cam surface along said guide; a polygonal shaped lifting member rotatably mounted to said second member and slidable along said cam surface;

said cam surface having a shoulder for rotating said lifting member when engaged by an apex of said lifting member as said slide means move apart.

17. The apparatus of claim **16** wherein said polygonal shaped member is a rectangle.

18. The apparatus of claim **16** wherein said polygonal shaped member is a square.

19. The apparatus of claim **16** wherein said polygonal shaped member is a triangle.

20. The apparatus of claim **16** wherein said polygonal shaped member is an equilateral triangle.

21. The apparatus of claim **1** including feed means comprises reciprocally mounted elongated member;

said member having a first pair of rotatably mounted pusher elements normally biased to stand upright;

said elongated member having a shoulder member;

said elongated memmber having a shoulder on one side of each element and a recess on the other side of the element;

means for reciprocally moving said elongated element between the downstream and upstream directions whereby in moving downstream, each pair pushes a filter out of said hopper and in moving upstream the elements rotate into said recess and slide beneath the filter just moved downstream.

22. The apparatus of claim **21** further comprising a second pusher element notatably mounted to said elongated member a spaced distance downstream from said first pusher elements and normally biased in the upstream direction to an upright position;

said elongated element having a second shoulder on the upstream side of said second element and a second recess on the opposite side of said second element;

the second shoulder in said elongated member being adapted to abut said second element causing said element to push a filter moved downstream and out of said hopper by said first element along said guide means.

23. The apparatus of claim **21** further comprising a third pusher element rotatably mounted to said elongated member a spaced distance downstream from said second pusher element and normally biased in the upstream direction to an upright position;

said elongated element having a third shoulder on the upstream side of said third element and a third recess on the opposite side of said third element;

the third shoulder in said elongated member being adapted to abut said third element causing said element to push a filter moved downstream along said guide means by said second element on to said blade means.

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